INTRODUCTION TO THE WORLD OF COMPUTERS

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Introduction – Introduction to the World of Computers

What is a computer?

A computer is an electronic device that receives information, can make changes to it, and presents it to the user in different ways.

In other words, the computer processes the data entered into it according to certain rules, modifies it, and presents the result in a form that humans can understand — such as text, graphics, sound, or video.

What are the basic components of a computer and what is its fundamental operating principle?

Power Supply (Power Supply Unit – PSU):

The power supply provides electrical energy to all components of the computer. It converts the 220V mains voltage into lower and stable values (for example 12V, 5V, 3.3V) that the computer can use. The quality of the power supply is extremely important for the stable and safe operation of the computer.

Motherboard:

The motherboard is the computer's "main circuit board." All other components — processor, memory, graphics card, hard drive, etc. — connect to the motherboard. It enables the flow of data between these parts and controls their compatible operation.

Central Processing Unit (CPU – Central Processing Unit):

The CPU is considered the “brain” of the computer. It executes the commands given by software, performs calculations, and processes data. The speed of the CPU is measured in “GHz.” As the number of cores increases, its ability to perform parallel processing also increases.

Random Access Memory (RAM – Random Access Memory):

RAM is the memory where programs and data are temporarily stored. While the computer is running, information is kept in RAM; however, when the power is cut, this data is erased. RAM is a fast type of memory and directly affects system performance.

Hard Disk or SSD (Hard Disk / Solid State Drive):

These devices provide long-term data storage. In hard disks, data is stored using magnetic methods; in SSDs, however, electronic memory chips are used. SSDs are considered superior to hard disks in terms of speed and durability.

Graphics Card (Graphics Processing Unit – GPU):

The graphics card processes graphic images and presents them on the screen. It is of great importance in graphics-intensive tasks such as games, video editing, and artificial intelligence applications. Although some processors contain an integrated graphics unit, a dedicated (separate) GPU is preferred for high performance.

Neural Processing Unit (NPU – Neural Processing Unit):

An NPU is a specialized processor designed to accelerate artificial intelligence and machine learning operations. It performs parallel calculations in a way similar to the working logic of neurons in the

human brain.

NPUs provide higher efficiency than the CPU and GPU, especially in tasks such as voice recognition, image processing, and natural language processing.

In modern laptops, smartphones, and servers, NPU modules are now becoming standard. In the future, NPUs are expected to integrate more strongly with operating systems and software.

These components work in close harmony with each other. If any of these parts develop a problem, the overall stability and performance of the system can be seriously affected. For this reason, both the correct selection of components and their proper installation are essential conditions for the efficient operation of the computer.

In addition, these components are considered the fundamental parts of most modern computers produced today.

🔆 1. What is a power supply (PSU – Power Supply Unit) and what is its basic function?

The power supply (PSU) is the device that converts electrical energy (220V AC) into stable voltages that computer components can use.

The power rating (Watt) of the PSU should be selected according to the total energy requirement of the computer.

⚙ 2. Minimum and maximum power levels:

◈ Low-level PSU — 200–350W

Office computers, mini PCs

Sufficient for a simple CPU + integrated graphics unit.

◈ Mid-level PSU — 400–650W

Mid-level gaming computers, workstations

Operates stably with a dedicated GPU and SSDs.

If a CPU and GPU selected for future overclocking will be used, it is more appropriate to choose a PSU that is 100W stronger than the standard 650W PSU watt value.

In general, selecting a PSU slightly more powerful than the total wattage required by all components of the computer helps the system run cooler, more stable, and with less stress.

◈ High-level PSU — 700–1000W

Systems with powerful graphics cards (RTX 4080, 4090)

Should be 80+ Gold or Platinum certified.

If a CPU and GPU selected for future overclocking will be used, it is more appropriate to select a PSU 100W higher than the standard 700–1000W PSU watt value.

In general, choosing a PSU slightly higher than the value required by all the components of the computer helps the system run cooler, more stable, and without problems.

In addition, server systems without a dedicated GPU (graphics card) and capable of going up to 128GB RAM are widely used in the world — they are suitable for basic and mid-level tasks.

◈ Extreme-level PSU — 1200–1600W and above

Servers, multi-GPU artificial intelligence systems

Used only in professional systems and data centers.

If a CPU and GPU selected for future overclocking will be used, it is more appropriate to choose a PSU 100W stronger than the standard

1200–1600W PSU.

In general, selecting a PSU that is slightly higher than the computer's total required watt value helps the computer run cooler, more stable, and with less stress.

- And there are PSU (power supply) models with higher wattage than the values listed above.

However, these PSUs are designed for heavier workloads.

Examples of more powerful PSUs (Power supplies):

Example Models

- ### 3000–3500W — High-end PC / Server PSU

Workstations operating with multiple GPUs, crypto mining systems

Super Flower Leadex Titanium 3000W, FSP Cannon Pro 3000W

- ### 4000–5000W — Industrial-type server PSU

HPC (High Performance Computing), artificial intelligence, render farms

Delta, Lite-On, Zippy 4000W redundant PSU (e.g.: 2 × 2000W module)

- ### 6000–8000W — Data center power modules

NVIDIA DGX, AMD Instinct systems

Supermicro, Dell EMC, HPE server power units

- 10,000W and above — Supercomputer PSU / Blade server power chassis

HPC systems, artificial intelligence training clusters

NVIDIA DGX H100, AMD MI300X rack power modules (~10–12 kW)

- 20,000W (20 kW) — Full rack (rack) power block / PDU

Large data centers and HPC infrastructures

Schneider Electric, Delta, Eaton PDUs (3-phase 380–415V input)

Additional information:

The world's most powerful supercomputers can contain thousands of PSUs (power supplies).

Example: The El Capitan supercomputer in the United States.

In general, such supercomputers include thousands, and sometimes tens of thousands, of CPUs, GPUs, and other computer components.

Motherboard (Mainboard)

💻 Motherboard – Definition

The motherboard is the main component to which all essential parts of the computer (CPU, GPU, RAM, SSD (SATA, NVMe, M.2), HDD, NPU, and power supply, etc.) are connected.

(This is also found in desktop computers, laptops, portable devices like the Steam Deck, and other similar systems.)

Desktop PC motherboards

Type (form factor)	Description
ATX	The most common standard, for gaming and work computers
Micro-ATX	Smaller boards, for smaller cases
Mini-ITX	Small form factor (SFF) computers
E-ATX	Extended ATX, for enthusiast and server computers
Custom	Unique designs for high-performance systems

Server and data center motherboards

Type	Description
SSI EEB	Professional servers, dual-processor systems
Blade server board	For blade servers, high-density servers
Proprietary server boards	Custom designs by companies like Dell, HP, Supermicro
GPU server board	For AI, machine learning, and artificial intelligence and multiple GPUs

Portable and gaming devices

Device type	Description
Steam Deck, ROG Ally	Custom motherboard (SoC + RAM + GPU integrated)
Game consoles (PS5, Xbox)	Custom designs based on AMD APU
Tablets and mobile devices	Small, integrated boards based on “SoC”

Laptop Motherboards

There is no standard size for laptop motherboards — each model has its own unique design.

Most components (CPU — except in older-generation laptops and not including some laptop manufacturers like Eurocom; RAM — a condition that applies to many of the newest laptops; and GPU) are soldered to the motherboard and cannot be replaced.

Only in some “modular” models is it possible to replace these components.

Manufacturers such as Eurocom, Clevo, and Framework produce modular-design laptops; in these models, the CPU, GPU, RAM, and even some sections of the motherboard can be easily replaced and upgraded.

Thus, most modern laptops lose their modular flexibility due to compact and dense design;

however, some professional and technically oriented models retain a fully repairable and replaceable structure.

Central Processing Unit (CPU – Central Processing Unit)

CPU is the abbreviation of the English term “Central Processing Unit.”

In our language, this is called the Central Processing Unit or simply the processor (CPU).

The CPU is like the brain of the computer.

It reads, processes, and produces results for all commands (for example, program calculations, operating system instructions).

In other words:

Every letter you type on the keyboard, every visual you see on the screen, every movement that occurs in games — all happen thanks to the calculations of the CPU.

💻 **Where is the CPU located?**

In desktop computers:

It is located on the motherboard and is covered with a cooler.

In laptops:

It comes in a smaller form and consumes less power.

In phones and tablets:

The CPU is usually inside the SoC (System on Chip) together with the GPU and RAM.

In game consoles and portable devices:

CPU + GPU are combined in the form of an APU.

The Most Famous CPU (Processor) Manufacturers in the World:

Main Brands and Models

PC, laptop

Ryzen, Athlon, portable devices

Intel Core i3, i5, i7, i9, M1, M2, M3, M4 and above

Celeron, Pentium, Xeon

Snapdragon, Dimensity

What is Intel?

Intel is a technology company headquartered in the United States, but with manufacturing facilities in various countries around the world, and is one of the most established and respected companies in this field globally.

It is mainly specialized in CPU manufacturing, but recently, since 2022, it has also become a GPU (video card) manufacturer with its Intel Arc series — known for being powerful and budget-friendly.

Considering its price and performance, it has been liked by PC gamers and other users.

This company has CPUs suitable for different segments:

◆ 1 ◆ **Intel Core i3 / i5 / i7 / i9**

These belong to Intel's older segment, but especially i7 and i9 are the most powerful CPUs.

i3 — entry level

Daily use: browser usage, small and mid-level games, office programs, email applications.

More budget-friendly compared to the i5.

i5 — mid level

Can smoothly handle mid-level games, VMware, emulators, mid-level video and photo editing programs.

Also suitable for audio editing, mixing, and workloads that are not too heavy.

More budget-friendly compared to the i7 and i9.

i7 — for medium and higher-level workloads

Designed for software work, games, and similar tasks.

Example: Live streaming (e.g., Discord, Twitch, YouTube Live).

Suitable for many medium and relatively heavy workloads.

More budget-friendly compared to the i9.

i9 — professional and most powerful level

Designed for very heavy workloads and professional software.

Examples: rendering, 3D modeling, scientific calculations, large video projects, high-FPS games; game-engine software (Unreal, Unity); running multiple operating systems simultaneously in virtual machines; running multiple Android, iOS, and other emulators at the same time.

It is the most expensive CPU compared to i3, i5, and i7.

◆ 2 ◆ **Intel Atom**

These are the oldest but most budget-friendly CPUs produced by Intel.

Used in small computers and mini PCs for everyday tasks.

Usage purposes: web browsing, office documents, basic video and audio media programs, and small-scale video games.

◆ 3 ◆ **Intel Pentium**

First produced by Intel in 1993.

It is an old but budget-friendly CPU and has been used in many older-generation laptops and PCs.

Has a fixed (GHz) clock speed (does not have Turbo Boost like new Intel i5, i7, i9 models).

Turbo Boost automatically activates when the CPU's base speed is insufficient and more speed is required for programs.

This CPU can run many old-generation video games

(examples: GTA San Andreas, older versions of Call of Duty, FarCry 1, FarCry 2, etc.).

◆ 4 ◆ **Intel Celeron**

Intel Celeron processors are budget-friendly models designed for daily use.

Although they belong to an older segment, they are still found in many office laptops.

Used mostly in entry-level desktop and laptop computers.

They have enough power for simple web browsing, email, office documents, watching movies, and light media programs.

They can also run old and light video games (examples: Counter-Strike 1.6, Age of Empires II, SimCity 4, etc.).

Not suitable for heavy games and professional software.

Since they have fixed and moderate clock speeds, laptops with these CPUs have good battery life.

◆ 5 ◆ **Intel Xeon**

One of the most powerful CPU segments produced by Intel.

Usually used in servers and workstations.

They are among the CPUs with the highest RAM support produced by Intel.

Example: Apple Mac Pro 2019 used Intel Xeon W, which supported up to 1,500 GB of RAM.

It is no longer manufactured today (new-generation M2-chip Mac Pro models support a maximum of 192 GB of RAM).

Advantage of Xeon CPUs — availability of models suitable for different budget levels.

Example: E3-1246 V3 model (around 25 USD on platforms like eBay).

Although it is a server CPU, it can also be used in desktop PCs if compatible with other components.

Many of them provide more powerful and stable performance than 10th-generation Intel i5 CPUs (because they have larger L1, L2, and L3 caches).

The strongest Xeon segments are currently **Xeon Max Series** and **Xeon Platinum (new generation)** CPUs.

Very high performance: some models have 60+ physical cores and 120+ threads.

These CPUs support several terabytes of RAM.

They are more suitable for HPC (High Performance Computing),

artificial intelligence (AI), supercomputers, large data centers, and servers.

Due to their high price, they are not suitable for standard home users.

◆ 6 ◆ **Intel Core Ultra 5, 7, 9 (New and Most Well-Known)**

“Ultra” series processors are Intel’s newest and most modern high-level CPU family.

This family offers high performance, new technologies, and wide usage areas.

Suitable for high-performance tasks: video editing, 4K/8K editing, 3D modeling, gaming, and programming.

In portable (laptop) devices — used in “ultra-thin” and “long battery life” systems.

Supports artificial intelligence (AI) applications and machine learning:

The Ultra family comes with an NPU (Neural Processing Unit) set.

Example: **Core Ultra 9 285K** — comes with 24 cores, up to 5.7 GHz boost frequency, and a very large cache amount.

Since the newest-generation laptops use this CPU, they have long battery life; for standard tasks, they provide an average of about 22 hours of battery life.

What is AMD?

AMD is a technology company founded in 1969 in the United States

by Jerry Sanders and others.

Its main purpose: to compete with Intel and produce high-performance processors and chipsets.

During the 1980s–1990s, AMD began producing x86 processors and entered into competition with Intel.

(Many modern CPUs also use the x86-64 architecture to manufacture processors. For this reason, many older software applications can still run compatibly on many CPUs.

Example: We cannot place a 64-bit object into a 32-bit space, but we can easily place a 32-bit object into a 64-bit space.

Therefore, a CPU with 64-bit capability can also run 32-bit programs.)

Additionally, software that can run on 32-bit CPUs using x86 is decreasing over time.

Microsoft has reduced support for the Windows 10 operating system with 32-bit support as of 2025.

However, some operating systems and software with 32-bit support still exist, although limited.

After 2006, AMD acquired ATI Graphics and began producing graphics cards.

From that year onward, it became the most serious competitor to NVIDIA.

Additionally, compared to NVIDIA, AMD offers video cards that are more affordable, have more VRAM, and are more powerful for users.

However, because ray tracing on AMD video cards is not as advanced as on NVIDIA cards, AMD still cannot dominate the GPU market.

But this feature is more important for PC gamers, so it is not necessary

for everyone.

AMD CPU Segments:

◆ 1 ◆ AMD Athlon

AMD Athlon processors are entry-level CPUs that provide basic performance for budget-friendly computers.

They are sufficient for daily use such as simple office work, internet browsing, email, and light media programs.

In short: similar to Intel Celeron/Pentium, suitable for daily tasks.

◆ 2 ◆ AMD Ryzen 3

A CPU designed for transitioning from entry-level to mid-level usage.

It provides enough power for mid-level games, office programs, and video/photo editing.

Its competitor, Intel i3, offers similar performance and can be better in some cases.

Some models include an APU system (similar to some Intel models).

(APU — used for processors that have a graphics module inside the CPU, and APU systems are usually sufficient for simple and mid-level graphics workloads.)

◆ 3 ◆ AMD Ryzen 5

Mid-range processors.

Usage areas: more complex games, creative work (video/photo editing), virtual machines, and emulators.

Its competitor, Intel i5, offers similar performance and can be better in some cases.

Ideal for mid-level workloads.

- 4 - AMD Ryzen 7

Mid-range and high-performance processors.

Suitable for mid-level and relatively high workloads.

Usage areas: streaming, gaming, professional video/photo editing, and parallel software tasks.

Its competitor, Intel i7, offers similar performance and can be better in some cases.

Ideal for mid-level and high-level workloads.

- 5 - AMD Ryzen 9

Professional and very powerful processors.

Suitable for rendering, 3D modeling, high-FPS games, virtual machines, and AI applications.

Its competitor, Intel i9, offers similar performance and can be better in some cases.

Ideal for high-level workloads.

- AMD CPUs based on Zen architecture
- AMD Threadripper

Designed for workstations, these are considered the most powerful CPUs after AMD EPYC.

High-end models support up to 1 TB of RAM (new 1024 GB RAM).

They can be comfortably used for professional work, rendering, design, engineering, and creative tasks.

Their price is around 2,500 USD.

◈ AMD EPYC

AMD's most powerful processor family designed for servers, data centers, and high-performance computing (HPC) systems.

These CPUs stand out with a large number of cores, large cache, and wide RAM support.

They have high energy efficiency and can manage multiple virtual machines and server processes simultaneously.

Used for HPC, AI, cloud computing, rendering, and large databases.

Supports up to 6 TB of DDR5 RAM.

The most expensive processor produced by AMD.

High-end models can sell for up to 6,000 USD.

Considered the closest and strongest competitor to Intel Xeon.

Since these CPUs are not compatible with every motherboard, specially designed motherboards are required.

What Are Apple Silicon M1, M2, M3, M4 and Why Are They Produced?

Apple Silicon is a family of processors developed by Apple for its own computers and tablets, based on ARM architecture.

Since 2020, Apple has gradually abandoned Intel processors and transitioned to its own chip design.

This transition is considered a revolution in terms of both performance and energy efficiency.

Apple Silicon chips have a "SoC – System on a

Chip” design.

This means that the CPU, GPU, RAM, NPU (Neural Engine), and other control blocks are all located on the same chip (inside a new main CPU).

This structure offers a different approach from Intel and AMD systems in terms of both energy savings and data transfer speed.

It is also built on the RISC architecture.

Unlike CISC architecture, CPUs with RISC architecture operate through software differently than CPUs with CISC architecture and are designed to extract maximum efficiency from the device.

CPUs with CISC architecture operate based on hardware.

The higher the power of the hardware, the more valuable, faster, stable, and high-performing the operating system and software running on CPUs with this architecture will operate.

Although RISC and CISC appear similar, each is a separate and different world.

◆ 1 ◆ Apple M1

The beginning of the revolution (2020).

The M1 was introduced for the first time in November 2020.

It created a major shock in the computer world.

In terms of performance, this CPU rivaled the Intel i7 and was even 2–3 times more efficient than the i7 while consuming less energy.

The M1 CPU was highly appreciated among photo/video editors, DJs, sound engineers, and many creative professionals when it was first released.

These CPUs created a revolution in the Apple ecosystem with their

stable laptops and long battery life.

The CPUs are only compatible with Apple Mac devices.

The Apple M1 chip supports Unified Memory Architecture (UMA) using LPDDR4X memory.

High-end models such as Pro, Max, and Ultra also exist.

The base model of the M1 supports 16 GB, M1 Pro supports 32 GB, M1 Max supports 64 GB, and M1 Ultra supports 128 GB of RAM.

◆ 2 ◆ Apple M2

The Apple M2 chip was introduced in June 2022.

Even though it was released about 18 months after the M1, it offered significant improvements in many key technical areas.

It has support for a new RAM technology — LPDDR5. LPDDR5 is more energy-efficient and higher-performing compared to LPDDR4X.

The base model of the M2 supports 24 GB, M2 Pro supports 32 GB, M2 Max supports 96 GB, and M2 Ultra supports 192 GB of RAM.

In short, it is an improved version of the M1 CPU.

◆ 3 ◆ Apple M3

The Apple M3 series (M3, M3 Pro, M3 Max, M3 Ultra) was introduced in October 2023 and brought 3-nanometer chip technology to the Apple Silicon family for the first time.

This makes the M3 both more powerful and cooler.

Shorter transistor distance means higher performance and less energy loss.

The M3 CPU is equipped with a new GPU architecture (Dynamic Caching), and the GPU working together with this CPU now divides resources dynamically.

This eliminates unnecessary energy and memory loss during graphic tasks.

This feature provides more stable FPS, lower heat, and more efficient graphic processing.

It also has hardware ray tracing technology.

The advantage of this chip is that it can perform ray tracing internally without needing a dedicated external GPU like NVIDIA.

The base model of the M3 supports 24 GB, M3 Pro supports 36 GB, M3 Max supports 128 GB, and M3 Ultra supports 192 GB of RAM.

◆ 4 ◆ Apple M4

The Apple M4 processor is a new stage of the Apple Silicon family and stands out with its core innovations.

It is built on a 3-nanometer process (TSMC N3E) — which means lower energy consumption and higher performance.

The M4 processor is not just a new model but also a more efficient, more powerful, and future-oriented platform.

If you want long lifespan, high performance, and compatibility with future software on your device, the M4 can be an ideal choice in terms of specifications.

The base model of the M4 supports 32 GB, M4 Pro supports 64 GB, and M4 Max supports 128 GB of RAM.

(🔔 Additional information: These CPUs are built on ARM architecture.)

What Is ARM:

ARM (Advanced RISC Machines) architecture is based on the RISC (Reduced Instruction Set Computing) principle.

To put it simply, this architecture is built on the philosophy of “doing more with fewer instructions.”

Thanks to this, ARM-based processors are both energy-efficient and run cooler.

In the beginning, ARM chips were designed for mobile devices and smart systems.

However, in recent years, with the advancement of technology, this architecture has found its place in laptops, tablets, servers and even supercomputers.

However, these segment processors do not have as broad a software ecosystem as Intel and AMD.

Therefore, when you own an ARM-based device, it is important to check in advance whether the software, drivers and system support you need are available.

These processors became popular mostly with the Raspberry Pi.

Qualcomm / MediaTek

- **1** - **What Is Qualcomm**

Qualcomm is a US-based technology company and is especially known for its Snapdragon series.

These chips are produced for mobile phones, tablets, and sometimes laptops.

Qualcomm’s main advantage — stable performance, low energy consumption, and strong modem technology.

Snapdragon processors offer not only the CPU, but also the GPU (Adreno), the AI processor (NPU), the network modem (5G/4G), and multimedia blocks together.

Laptops produced with this chip are progressing toward becoming the closest competitors to MacBook devices and are currently still under development.

However, since they belong to the ARM architecture, they do not have as broad software support as Intel x86/x64 architecture CPUs.

Work is being done to eliminate this difference in the future.

- **2**
- **What Is MediaTek**

MediaTek is a Taiwan-based technology company and is one of the companies that produces the most mobile processors in the world.

Its main purpose — offering powerful performance at an affordable price.

MediaTek chips are widely used especially in mid-range and entry-level smartphones.

These processors are energy-efficient, stable for daily use, and often more affordable.

RAM (Random Access Memory) – Processor Memory: What Is It

◆ **1** ◆ RAM is a memory unit that temporarily stores all the data currently used by the programs and the operating system running on the device.

RAM is much faster than permanent storage units such as HDD and SSD, but the main difference is this: when the power is cut, all data in RAM is erased.

The main difference between RAM and HDD:

HDD or SSD is the main storage where all files on the computer are kept (operating system, software, documents, drivers, etc.) (excluding the software in BIOS/UEFI).

RAM temporarily holds the portion of these data that is being actively used, allowing the processor (CPU) to access it faster.

To explain this process with a simple analogy:

HDD — is like a “ground location” (all files are stored there).

RAM — is like a “ladder” leading to that location.

So, program files are stored on the HDD, but when the program starts running, this data is moved into RAM.

RAM temporarily holds this data so that the CPU can access it quickly and without interruption.

In short: If a program is a “person,” the HDD is the place where they stand, and the RAM is the ladder they use to reach that place.

The higher the RAM capacity in GB, the more parallel processes can be done simultaneously—if the CPU supports it.

Additionally, RAM is one of the longest-lasting components of a device and, under good conditions, can operate without issues for approximately 15–20 years.

- **RAM Types and Technologies**

- **DDR (Double Data Rate)**

This technology is considered a revolution in RAM history.

The main idea of DDR — is the ability to send data twice per second.

In previous technologies, data was transmitted once per “cycle” (clock cycle), but DDR does it twice.

This is like opening two lanes on a road — more cars (data) can move at the same time.

DDR1

DDR1 holds its place as the first step in the history of memory technology.

This generation was first produced by Samsung in June 1998.

In the 2000s, it began to be used in PC computers.

DDR1 RAM frequencies range from about 266 MHz to 400 MHz.

Additionally, these RAM modules require about 2.5V of power to operate.

A single DDR1 RAM module has a maximum capacity of 1 GB (per slot). But for server/workstation DDR1 RAM, this capacity can go up to 2 GB.

DDR2

DDR2 is the second step in development.

The DDR2 memory generation began production in 2003 and quickly replaced DDR1 in the computer world.

Its main purpose — to provide higher speed and lower energy consumption.

DDR2 RAM works at frequencies from 400 MHz to 800 MHz, approximately twice as fast as the previous generation.

In terms of energy, it now operates at 1.8V — meaning less heat and better energy efficiency.

Additionally, DDR2 RAM uses a more efficient “prefetch” technology to increase internal data transfer capacity (data rate).

Simply put, RAM could now “read and write more data at the same time.”

Models with 1 GB, 2 GB, or 4 GB capacity per slot are available.

◈ **DDR3** ◈

DDR3 can be described as the “era of speed and stability” in memory technology.

This RAM generation was introduced in 2007 and quickly became the most widely used memory type in both desktop and laptop computers.

The main differences — energy efficiency and higher frequencies.

DDR3 RAM operates at frequencies from 800 MHz to 2133 MHz and consumes only 1.5V (1.35V in mobile versions — DDR3L).

In terms of capacity, DDR3 RAM modules were produced up to 16 GB (per module), and for servers, this amount can exceed 32 GB.

The biggest advantage of DDR3 — stable performance and good price balance.

For many years, it remained the main memory technology for gaming PCs, workstations, and servers, and it is still used today.

◈ **DDR4** ◈

DDR4 is a new stage in memory technology in terms of speed, energy efficiency, and stability.

This RAM generation was introduced in 2014 and quickly became the standard in both gaming computers and server systems.

Main differences:

* **Frequency range:** Starts at 1600 MHz and goes up to 3200 MHz and beyond (overclocked models can exceed 5000+ MHz).

* **Energy consumption:** Reduced from 1.5V to 1.2V. This means less heat and longer lifespan.

* **Capacity:** From 4 GB to 64 GB per module. Server and workstation models offer up to 256 GB per module.

* **Technology:** The bank structure and burst length (BL8) system were improved, making data transmission more efficient.

Simply put, DDR4 RAM manages data more intelligently, meaning the system works “smarter” and faster.

◈ **DDR5** ◈

DDR5 is the generation that opens the door to the future of memory technology.

This generation was introduced in 2020, and its main purpose is to provide “unlimited” speed and optimized energy efficiency.

* **Frequency:** Starts at 4800 MHz and can reach 8000–9000 MHz in some models.

* **Energy consumption:** Reduced from 1.2V to 1.1V. This means less heat, a more stable system, and longer battery life.

* **Updated internal structure:** Each module is divided into two independent 32-bit sub-channels.

→ RAM can now operate with two different data streams simultaneously, significantly increasing parallel performance.

* **Capacity:** A single module can now reach up to 128 GB. For servers, options range from 256 GB to 2 TB (per slot).

Hard Disk or SSD (Hard Disk / Solid State Drive)

1- HDD (Hard Disk Drive) — What Is It?

HDD — Hard Disk Drive is the permanent storage unit of the computer. In other words, even if the power is cut, the data is not deleted. This unit stores all files, programs, the operating system, and documents.

HDDs operate using a mechanical principle: they contain rotating magnetic disks (platters) and a read/write head that reads and writes data. As the disk rotates, the head reads or writes the data on it — this is very similar to how a record player works.

For PCs and servers, HDDs are thicker in size. But HDDs produced for laptops are smaller and thinner. However, an HDD produced for PC

can be connected to a laptop using special USB converters and adapters. Likewise, an HDD produced for a laptop can also be used in a PC.

The speed of an HDD depends directly on the RPM (revolutions per minute). Among HDDs, there are two most popular disk rotation standards: one is 5200 RPM, and the other is 7200 RPM. Therefore, an HDD with 7200 RPM provides faster read/write performance than an HDD with 5200 RPM. In short, the higher the HDD RPM, the faster the computer operates.

In addition, the most common form factor for HDDs is the SATA form factor. Most modern HDDs use the SATA (Serial ATA) interface — this is the most widely used connection standard for both desktop and laptop computers.

🔔 **Note:** Since HDDs have rotating mechanisms, they consume more energy in laptops.

Advantages:

🔹 1 🔹 Large capacity — 1 TB, 2 TB, even 20 TB and higher models are available.

🔹 2 🔹 Affordable price — they are cheaper than SSDs with the same capacity. For this reason, the world's largest companies' data centers (Google, YouTube, and others) still mostly use HDDs.

🔹 3 🔹 Suitable for archiving and long-term data storage.

Disadvantages:

🔹 1 🔹 Since they contain mechanical parts, they are sensitive to impact.

🔹 2 🔹 Due to rotating parts, they produce noise and heat.

🔹 3 🔹 Read/write speed is lower than RAM and SSD (average 80–160 MB/s).

🔸 4 🔸 Since they have moving mechanical parts, in case of power outages, they are the first units to be damaged. This can lead to corruption of operating system files or other files.

Sometimes for this reason, blue screen errors occur in the Windows operating system, and although the computer turns on, it cannot be used properly because the OS does not load.

This issue is most common in relatively newer generation laptop HDDs. Laptop HDDs are more fragile and more prone to failure compared to PC HDDs.

2- SATA SSD (Serial ATA Solid State Drive) 💾 — What Is It?

SATA SSD — is the most common type of storage that appeared in the first stage of the transition from HDD to SSD technology.

🔔 **Compatibility:**

Since it uses the traditional SATA interface, it works smoothly with almost all old and new desktop computers, laptops, and game consoles.

💰 **Reason:**

A SATA SSD is the easiest and most effective way to speed up old computers and laptops by 5–8 times with a very low budget.

🔹 **Working Principle:**

SATA SSDs use the same cable and connector (SATA) as HDDs, but store data in NAND Flash memory chips instead of a mechanical disk. Since there are no rotating parts, reading and writing occur entirely electronically.

⚡ **Speed:**

The SATA III interface provides real speeds of 550–560 MB/s.

Compared to traditional HDDs (100–180 MB/s), this means 4–8 times higher performance.

➜ Windows 11 usually boots in 8–15 seconds with such an SSD, and programs and games start almost instantly.

Main Advantages: ✓

⚡ Consumes very little energy → increases laptop battery life by 30–60 minutes

🔇 Operates completely silently

🌡️ Produces very little heat

🛡️ Far more resistant to shock, vibration, and dropping than HDD

🪫 Not physically damaged during power cuts because it has no rotating mechanism

🔔 **Important Note – Power Loss:**

High-quality SATA SSDs (Samsung 870 EVO, Crucial MX500, WD Blue SA510, Kingston A400, etc.) have power loss protection; thus, data loss during sudden power cuts is prevented.

In cheap and DRAM-less models, this risk may be slightly higher.

Weak Points (for 2025): ✖

PCIe NVMe SSDs are 8–15 times faster (550

MB/s vs 5000–7500 MB/s)

New motherboards have fewer SATA ports; most come with only M.2 NVMe slots

In large capacities (2 TB+), HDDs are still cheaper

But in capacities of 1 TB and below, SATA SSD is now cheaper than HDD (1 TB SATA SSD ≈ 45–65 AZN, 1 TB HDD ≈ 80–110 AZN).

Conclusion: 🎯

If you want to revive an old computer or laptop → SATA SSD is still the best and cheapest option.

If you are building a new system and the motherboard has an M.2 NVMe slot → NVMe SSD makes more sense.

If your budget is limited → SATA SSD is indispensable.

3- NVMe SSD (Non-Volatile Memory Express) 💾⚡ — What Is It?

NVMe SSD — is the fastest and most modern SSD technology available today. It operates through the PCIe interface and provides 6–14 times higher data transfer speed compared to SATA SSDs because it communicates directly with the CPU.

Compatibility 🖥️🔌

Most new-generation laptop and desktop motherboards support NVMe SSDs through the M.2 slot.

Older motherboards (until 2014) generally do not support NVMe — therefore, it is important to check “M.2 PCIe NVMe” support before purchasing.

Who Is It Ideal For? 🎯

Gamers (loading large games in seconds) 🎮

Video editors (4K/8K editing) 🎬

3D rendering, programmers, virtual machine users 💻

Anyone who wants maximum performance ⚡

Speed (2025 models) 🚀

PCIe 3.0 ×4 → 3000–3500 MB/s

PCIe 4.0 ×4 → 5000–7500 MB/s

PCIe 5.0 ×4 → 10 000–14 000 MB/s (2024–2025 models)

Real usage:

Windows 11 boot time → usually 10–18 seconds ⏱

Large games (100 GB+) → 8–15 seconds 🎮

Programs and files → open almost instantly ⚡

Main Advantages ✓

⚡ Extremely high read/write speed

🔇 Completely silent operation

🌡️ Low heat production (with good cooling)

🛡️ Very resistant to shock and vibration

🔋 Better energy efficiency than SATA SSD (finishes tasks quickly and goes into “sleep mode”)

💾 Large files are transferred and processed at record speed

Important Note – Power Loss ⚡

NVMe SSDs do not contain mechanical parts, so they are not physically damaged.

However, sudden power loss during writing may cause data loss or file system corruption.

High-quality models (Samsung 990 PRO, WD Black SN850X, Seagate FireCuda 540, Kingston Fury Renegade, etc.) have Power Loss Protection capacitors that reduce this risk almost to zero ✓

In cheap and DRAM-less models, the risk is slightly higher ⚠️

Weak Points ✗

1.6–2.2 times more expensive than SATA SSD with the same capacity 💰

Does not work on old motherboards

High-speed models can produce more heat during use (heatsink recommended)

Prices for capacities over 4 TB are still high 💵

Estimated Prices for 2026 (Turkey Market) 💵

1 TB NVMe (PCIe 4.0) → 4K TL and above

2 TB NVMe (PCIe 4.0) → 10K – 24K TL

1 TB SATA SSD → 4K – 5.5K TL

Conclusion 🎯

If you are building a new system or buying a high-performance laptop → NVMe SSD is an essential choice ⚡

If you want to speed up an old computer/laptop → SATA SSD is more suitable 💾

If you want maximum speed, comfort, and a future-proof system → get an NVMe SSD, you won't regret it! ✓

Graphics Card (Graphics Processing Unit – GPU) What Is It?

A graphics card is the fundamental unit that processes graphical data in a computer. That is, every visual element we see on the screen — images, videos, 3D models, game graphics, and interface elements — is processed by the GPU and sent to the monitor.

While the CPU performs various tasks sequentially, the GPU can perform thousands of graphical operations simultaneously thanks to its parallel processing power.

The GPU is not only for gaming:

AI and Deep Learning

Crypto Mining

Android/iOS Emulator Farming

Video editing and 3D rendering

In these fields as well, the GPU plays a very important role.

**Main Components of a Graphics Card **

GPU chip – the main computation center (cores are located here)

VRAM (Video RAM) – high-speed memory where graphical data (textures, frames, buffers) is temporarily stored

Cooling system (Fan / Heatsink) – prevents the chip from overheating ❄

VRM (Voltage Regulator Module) – regulates power ⚡

Display outputs (HDMI, DisplayPort, DVI, VGA) – provide connection to the monitor 🖥

Main Specifications of a GPU 📊

Core Clock (MHz) – operating speed of the cores ⏱

Number of CUDA / Stream cores – the more there are, the more parallel operations can be performed ⚡

VRAM Amount and Type (GDDR5, GDDR6, HBM, etc.) – affects speed and performance 💾

Bus Width (Bit) – width of the data transfer channel; e.g., 128-bit, 256-bit 🔗

TDP (Thermal Design Power) – indicator of power consumption and heat output

🔹 **Types of GPUs** 🔹

Integrated GPU

Built inside the CPU.

It is energy-efficient but not as powerful as a dedicated GPU.

Sufficient for office work, internet browsing, watching movies, and simple graphics tasks.

Examples: Intel Iris Xe, Apple M1/M2/M3/M4 GPU, AMD Radeon Vega iGPU

Dedicated GPU

Connected to the motherboard as a separate unit and has its own VRAM.

Provides much higher performance but requires more power and cooling.

Examples: NVIDIA GeForce RTX, AMD Radeon RX, Intel Arc.

Detailed Explanation:

In general, we can think of dedicated GPUs as an additional helper and booster for our computer — almost like a separate computer or motherboard. Because this unit contains a chip similar to a CPU and

VRAM similar to RAM.

During normal use, while navigating the desktop, the GPU does not operate at full capacity, especially in laptops and PCs. But when you run high-performance programs such as CapCut or OBS Studio, the GPU automatically activates and helps the computer handle the workload comfortably.

This happens automatically, especially on laptops. In general, on laptops with APU (Integrated GPU) + Dedicated GPU systems, during simple browsing or basic tasks, the dedicated GPU stays passive. If you haven't activated the dedicated GPU permanently from settings for a browser or another program, this intentional passive behavior extends battery life and ensures more efficient energy usage.

What Is VRAM?

"VRAM" (Video Random Access Memory) — as the name suggests — is special memory used to temporarily store video data (all images displayed on the screen, textures, frames, 3D models, etc.). This memory is a special type of RAM that belongs to the GPU.

◆ **How Can We Understand VRAM Capacity as Power?**

Let's say you are playing a game and the screen is full of countless details — buildings, shadows, explosions, characters, textures… All this visual data is first loaded into VRAM, then processed by the GPU and displayed on the screen.

If VRAM capacity is low:

The GPU must repeatedly fetch this data from system RAM or the disk;

in this case, FPS drops, the game “lags,” and sometimes image quality is reduced so that the system does not choke.

◆ **Why Is VRAM Important?**

 It is the main storage area for graphical data: Textures, 3D models, shadow and lighting effects are stored in VRAM.

⚙ It ensures efficient GPU operation: The GPU retrieves all data instantly from VRAM; this is much faster than the connection between the CPU and RAM.

🎮 It is a critical factor for high FPS and stable performance: Especially in gaming, 3D rendering, and video editing, VRAM amount directly affects performance.

 It is required for high resolutions: 1080p, 4K, 8K, and even 12K video content means more data and more simultaneous elements to process — which requires more VRAM.

◆ **VRAM and GPUs in Servers** ◆

Traditional APU-based systems (where CPU and GPU are combined on the same chip) offer limited resources for highly parallel and graphics-intensive workloads.

However, large server infrastructures are now equipped with dedicated GPUs. The main reason is that dozens or even hundreds of graphics-based tasks are executed simultaneously.

For example:

To run hundreds of Android or iOS emulators on a server at the same time, the graphics processor and memory (VRAM) requirement for each virtual device is calculated separately.

For such workloads, the multi-core architecture and large VRAM capacity of GPUs provide an ideal environment. Therefore, server-grade GPUs — such as NVIDIA A100, H100, or AMD Instinct series — are equipped with 40 GB to as much as 192 GB of HBM2/HBM3 type VRAM.

This allows them to run hundreds of mobile emulators, AI models, rendering operations, and data analysis tasks simultaneously.

🌤 **In short:**

“A normal GPU is the power in the hands of a single player, but server GPUs are power centers designed so that hundreds of players can play at the same time.”

🌍 **Leading Countries in the Graphics Card Market**

🇺🇸 **1. United States – Global leader and innovation hub**

The U.S. plays the role of the brain center in the GPU industry.

Major tech giants are headquartered here:

* **NVIDIA** (Santa Clara, California)

* **AMD** (Austin, Texas)

* **Intel** (Santa Clara, California)

These companies design the architecture, technology, and software behind GPUs.

In other words, the *“intelligence and software”* side of GPUs is shaped entirely in the United States.

However, most physical manufacturing takes place in other countries (especially in Asia).

The U.S. Advantage in the Graphics Card Market:

* Global center for research and innovation

* Home of technologies like CUDA, DLSS, Ray Tracing, ROCm

* NVIDIA controls over 90% of the AI and data center market

🇹🇼 **2. Taiwan – The true production powerhouse (hardware center)**

Taiwan is the manufacturing leader of the global graphics card industry.

The world’s most important chip manufacturer, **TSMC (Taiwan Semiconductor Manufacturing Company)**, is located here.

NVIDIA, AMD, and Apple all produce their chips in TSMC factories.

Additionally, well-known GPU brands such as **ASUS, MSI, GIGABYTE, and ASRock** are also based in Taiwan.

In short: GPUs are *designed in the U.S.*, but *manufactured in Taiwan*.

Taiwan’s Advantages:

* The world’s most advanced chip manufacturing technology (3nm, 5nm)

* Top-tier cooling and motherboard technology

* 60–70% of the global GPU supply originates from Taiwan

What Is a Neural Processing Unit (NPU)?

An **NPU (Neural Processing Unit)** is a specialized processor designed to handle artificial intelligence (AI) and machine learning (ML) algorithms in a manner similar to how the human brain processes information.

Simply put, an NPU is the part of a computer that *“mimics neural activity.”*

NPUs are used especially in AI tasks such as:

* Speech recognition

* Image and video analysis

* Translation and natural language processing (e.g., ChatGPT, Siri, Bixby)

* Face and object recognition

* Camera optimization

They perform these tasks extremely fast and with very low power consumption.

This is why the rise of creative AI tools like **SUNO AI** coincides with the widespread adoption of NPUs.

A Simple Explanation of AI (Artificial Intelligence)

Many people think AI and automation are brand-new technologies. However, the foundation of AI was shaped years ago through video games.

Think about it:

When playing older games like **GTA: San Andreas, Vice City, Far Cry 1, or Call of Duty**, the NPCs (game characters), vehicles, animals, and other objects always reacted differently.

For example, when you approach an NPC, sometimes they run away, sometimes they fight, and sometimes they ignore you. These behaviors are created through probability-based game programming.

In other words, the *“AI”* in these games functioned so convincingly and naturally that for years we interacted with it without fully

realizing it.

These **manual but complex AI systems** in games — such as NPC decision-making algorithms, pathfinding, and combat strategies — laid the groundwork for the principles of modern AI models.

Over time, AI evolved into specialized models for different fields. For example:

* DAWs (digital audio workstations) that analyze or modify the BPM of an MP3/WAV

* AI-powered mastering tools like iZotope (virtual audio processing tools)

* AI technologies for photo editing, video production, and SEO optimization

All these AI technologies have been gradually developed and made available to users.

🎧 **How Does AI Understand and Analyze Music?**

For example, AI models used in the music industry cannot fully replicate the listening ability and emotional intelligence (EQ) of a professional human.

The emotional perception humans possess — the ability to understand the emotional impact, energy, and depth of a melody — does not yet exist in artificial intelligence.

However, AI models approach music not emotionally but mathematically.

By analyzing the billions of bytes and frequency values that make up an audio file (MP3, WAV, FLAC, etc.), they compute:

* Volume level

* Tempo (BPM)

* Chord structure (harmony)

* Timbre (sound color)

As a result, they provide the user with precise technical information or alternative variations.

This field is known in computer science as **Audio Programming**.

Powerful deep learning–based AI models developed in this area are now used at a professional level.

For example:

* DJs use AI for automatic mixing and mastering

* Musicians use it for rhythm and harmony analysis

* Audio engineers use it for automatic sound optimization

These systems are now actively utilized.

In conclusion, artificial intelligence is no longer just an analytical tool — it has become part of the creative process.

Furthermore, every profession and every domain now has AI models developed specifically for its subcategories.

What Is a Bot?

Bots are software programs that mimic human behavior either semi-automatically or fully automatically. Unlike humanoid robots, they have no physical components. They can only operate on a device such as a server, PC, game console, or mobile phone.

Bots have been evolving continuously since the 1990s. Although they are used in almost every field today, their capabilities have advanced to astonishing levels since 2016.

◆ **Most Common Types of Bots in the World** ◆

◆ **1. Chatbots** – Communicate with humans via text or voice and are now used for almost every purpose. This is one of the most heavily invested sectors.

Examples: ChatGPT, Siri, Alexa, Grok, Gemini, Claude AI, Meta AI, Copilot, DeepSeek, and many more.

◆ **2. Web Crawlers (Spiders)** – Scan websites to collect data and deliver it to the owner. They are the fastest and most effective tools for pulling information from the internet. For example, they can find every occurrence of the phrase “Thank you very much” in the comments of a YouTube video.

◆ **3. Trading Bots** – Developed to perform automated transactions in financial markets, often used in cryptocurrency trading. These bots track coin prices and can automatically buy or sell at the optimal moment.

◆ **4. Game Bots** – Automatically perform repetitive tasks in

games. Commonly used on Android/iOS devices and emulators.

◆ **5. Social Media Bots** – Automate tasks such as posting, liking, commenting, following, reposting, and replying to comments. By mimicking human behavior, they can perform parallel tasks either instantly or with delays, and they can run 24/7 on a PC or server.

Their purpose is to automate daily repetitive tasks and generate fast popularity and income for influencers. Through these bots, millions of interactions can be produced on a single server.

🌐 **The Dead Internet Theory**

The Dead Internet Theory is a claim put forward by certain technology experts and researchers:

That since 2016, a large portion of the internet is no longer operated by humans, but by bots.

◆ **Core Idea**

According to the theory:

* After 2016, the number of bots on the internet has vastly exceeded the number of real users.

* Most content on social media platforms and news sites is automatically generated by AI and bots.

* People are increasingly interacting with digital entities rather than real humans.

- **Elon Musk and the “Twitter Bot” Issue**

When Elon Musk purchased Twitter (now X) in 2022, he stated:

“The number of bots on this platform is about one-third of real users.”

This reveals that automated accounts that behave like humans now have massive influence. These accounts can create trends, generate fake popularity, and shape public opinion.

- **Risks of the Theory**

* **Disinformation:** Rapid spread of fake or manipulated news

* **Fake trends:** Artificially boosting the popularity of an idea or person

* **Social manipulation:** Steering society in a particular direction

* **Loss of trust:** It becomes harder to believe whether the content we see online is created by a real person

**What Is an Operating System (OS)? 🖥️💻📱 **

An operating system (OS) is the core software that acts as an intermediary between hardware and software on devices such as computers, laptops, tablets, or smartphones.

In simple terms:

The operating system is like the *CEO of the

computer*:

* It connects the user with the device and enables the management of the system;

* All resources (CPU, RAM, disk, GPU, NPU, display, etc.) are managed simultaneously by the operating system;

* It creates a stable, secure, and efficient environment for programs to run.

Core Functions of the Operating System

- **Resource Management**

It handles the allocation of CPU, RAM, storage, and input-output devices.

- **Process Management**

It allows multiple programs and services to run simultaneously and monitors them in real time.

You can observe this especially in Windows OS through Task Manager, or in many Linux distributions through tools like Gnome System Monitor.

Additionally, many operating systems offer this function natively, and via third-party software you can also monitor processes and stop them with the “Kill Task” command.

Through these tools, you can see in real time how much CPU, RAM, GPU, NPU, network, and disk resources each program is using.

You can also terminate resource-heavy or unresponsive processes with the “Kill Task” command.

- **File System**

Handles reading, writing, deleting, and organizing files on the disk.

- **User Interface (UI)**

Allows the user to enter commands using a graphical (GUI) or text-based (CLI) interface.

In some cases, such as with servers, the OS may only be managed through a terminal without offering a graphical interface—for example Ubuntu Server or Windows Server.

- **Security and Access Permissions**

Manages user accounts, passwords, and system permissions.

Most advanced operating systems aim to protect the user against viruses and are continuously improved for this purpose.

Examples of the Most Popular Operating Systems

- **Windows OS (Microsoft)** -

This is the most important leading OS in the world. It is the most widely used operating system among home users, government institutions, private companies, and many industries.

It holds approximately 70% of the global PC/home-user market and has a special role in the server world with OS models such as Windows Server 2016, 2022, and 2025.

These server operating systems are typically used for commercial purposes because many server OS systems do not offer as broad a program support, driver support, and similar features as Windows Server does.

Nearly all programs that run on normal Windows 7, 8.1, 10, and 11 can run 24/7 uninterrupted on Windows Server OS.

In contrast, Linux servers are mostly used for purposes such as website hosting (the storage area for all website files) or in more specialized

fields—for example, as the main OS for supercomputers.

Advantages of the Windows Operating System

* It is the richest operating system in the world in terms of programs, drivers, and external device software/driver support.

* There is almost no field in the world where it is not used.

* It is compatible with the hardware of almost all PC brands produced globally.

* Even small computers with ARM-based CPUs have special versions of Windows.

For this reason, it has been an indispensable operating system worldwide for years—especially for gaming enthusiasts (PC gamers) and professionals in many fields.

Strengths and Relative Weaknesses of Windows OS

◆ **STRENGTHS** ◆

 Wide software compatibility:

Almost all software developed in the world (Office, AutoCAD, Photoshop, Cubase, Premiere Pro, etc.) is designed primarily for Windows.

Therefore, Windows is the most flexible platform for both personal and professional users.

🎮 **Gaming support:**

It is the most optimized operating system in the gaming industry.

Thanks to DirectX technology, graphics performance is very high, and all popular games (GTA, Call of Duty, Far Cry, Valorant, etc.) are developed primarily for Windows.

🔧 **Device and driver compatibility:**

Windows works smoothly with hundreds of thousands of devices from different manufacturers (printers, internal or external sound cards, GPUs, cameras, etc.).

Thanks to Microsoft's "Plug and Play" system, many devices are recognized automatically.

 User-friendly interface:

Simple and clear menus, visual management, and multilingual support make Windows user-friendly for both beginners and experts.

🌍 **Global support and resources:**

There are countless tutorials, forums, and technical help resources online for Windows.

This makes problem-solving much easier compared to Linux or macOS.

 Strong ecosystem and integration:

It integrates tightly with Microsoft's other products (OneDrive, Azure, Office 365, Xbox Cloud, etc.).

This provides a complete ecosystem for both individual and corporate users.

🔻 **RELATIVE WEAKNESSES** 🔻

 Susceptibility to viruses and malware:

Because Windows has the highest market share, it is the most targeted OS by malware developers.

Therefore, antivirus software and regular updates are important for security.

⚙ **High system resource usage:**

Newer Windows versions (especially Windows 10 and 11) consume more RAM, CPU, and disk resources.

Performance may be lower on older or low-spec computers.

💰 **Licensing and cost:**

Windows OS and Microsoft products like Office are paid.

Unlicensed or cracked versions can pose security and legal risks, especially for companies.

 Occasional instability of updates:

Some Microsoft updates can cause system stability issues or driver incompatibilities.

This can be a serious problem for enterprise users.

 Automatic background processes:

Windows runs many background services (telemetry, update checks, Cortana, etc.), which can increase RAM, CPU, and disk usage without the user noticing.

And the Hardware Limits of These Operating Systems:

◆ **1 ◆ Windows 11 Home**

Parameter	Official Value
Maximum RAM (64-bit)	128 GB
Number of physical CPUs	1
Physical cores	64 (inside 1 CPU)
Logical processors	64 (on systems with Hyper-Threading it can be doubled, but the limit is 64)
Additional features	Microsoft Store, Cortana, Edge available; BitLocker, Remote Desktop, Domain Join not available

Official note:

Windows 11 Home is designed for personal use. It supports 1 physical CPU with a maximum of 64 physical cores and 64 logical processors.

◆ **2 ◆ Windows 11 Pro**

Parameter	Official Value
Maximum RAM	2 TB (2048 GB)
Number of CPUs	2
Physical cores	128 (distributed between 2 CPUs, e.g., 64 + 64)
Logical processors	128 (on systems with Hyper-Threading it can be doubled, but the limit is 128)
Additional features	BitLocker, Remote Desktop, Hyper-V, Group Policy, Azure AD, Domain Join

Windows 11 Pro supports 2 CPUs and 128 cores along with 2 TB of RAM.

◆ **3 ◆ Windows 11 Education**

Parameter	Official Value
Maximum RAM	2 TB
Physical CPUs	2
Maximum cores	256 cores
Additional features	Windows Defender ATP, AppLocker, DirectAccess,

◆ **4 ◆ Windows 11 IoT Enterprise LTSC 2024**

Parameter	Official Value
RAM / CPU	Same as Enterprise → 6 TB, 2 CPUs, 256 cores
Support duration	10 years (until 2034)
Update policy	Security updates only
Microsoft Store, Cortana, Xbox apps	Not available
Windows Edge	Available (some functions limited)

Windows 11 Enterprise supports 6 TB of RAM and 2 physical CPUs with a maximum of 256 cores.

◆ **5 ◆ Windows Server 2025**

To run this operating system, the minimum RAM requirement is 512 MB, and it is the OS with the highest RAM support in the Windows family.

Windows Server 2016 / 2019 — maximum 24 TB RAM

Windows Server 2022 / 2025 — maximum 48 TB RAM or more

In general:

For most operating systems, the real limitation is determined by the motherboard and CPU architecture of the device.

Additional Information:

Let's say you have a PC with 8 GB of RAM and a CPU suitable for x64 architecture, and you install a 32-bit operating system on it, for example Windows 10 32-bit — the computer will boot and work normally.

However, the operating system will not be able to detect more than 4 GB of RAM.

Also, on the internet there are many Windows OS examples and versions that are not officially supported by Microsoft, modified and requiring fewer resources, such as Atlas OS, Tiny10, Tiny11.

However, some similar examples may carry certain security risks for the device.

What Is OS X / macOS?

macOS is an operating system developed by Apple and designed exclusively for Mac devices.

The origins of this operating system go back to 1984, to the invention of the first Macintosh computers.

Modern versions of macOS are Unix-based; meaning the foundation of the system is stability, security, and performance.

Apple designed macOS to be fully integrated into its own ecosystem — this is one of its biggest advantages.

In other words, it works seamlessly with the iPhone, iPad, Apple Watch, and even Apple TV.

For example, you can copy text on your iPhone and paste it on your Mac with Command + V — this is possible thanks to "Continuity" and "Handoff" technologies.

◆ Architecture of macOS

macOS is built on an open-source Unix kernel called Darwin.

Darwin is based on a kernel named XNU (X is Not Unix), and this structure resembles both Linux and BSD systems.

The user interface of macOS is called Aqua — it provides users with simplicity, fluid animations, and an intuitive experience.

Across the entire system, tools such as *drag and drop*, *gesture control*, and *Spotlight search* significantly increase productivity.

◆ Core Features of macOS ◆

✓ **Stability and Security:**

In Unix-based systems, the likelihood of malware breaking the system is very low.

✓ **Optimized Performance:**

Since macOS runs only on Apple devices, it is optimized specifically for each model.

✓ **Ideal for Creators:**

It is considered an “industry standard” for designers, musicians, developers, and video editors (Final Cut Pro, Logic Pro, Xcode, etc.).

✓ **Ecosystem Integration:**

Features like AirDrop, iCloud Drive, and Universal Clipboard ensure perfect harmony between devices.

◆ Relatively Weak Sides ◆

⚠ **Limited Software Support:**

Although many popular applications support macOS, not all Windows programs and some external devices or games have official macOS support (however, tools like “Parallels Desktop” and “Crossover” can solve this in most cases).

⚠ **Price:**

Apple devices and components are expensive.

However, Mac devices have certain hardware advantages that many Windows-compatible laptops and desktops do not offer.

⚠ **Relatively Closed System:**

macOS is officially designed only for Apple devices.

Installing it on a different PC through unofficial methods is called Hackintosh.

This process requires advanced technical knowledge and experience.

The OS image file (ISO) can be modified to adapt it to a regular PC; it is generally suitable for computers with Intel CPUs (because Macs produced until 2020 used Intel CPUs).

However, it is not guaranteed to work 100% stably on all brands and models.

If you use Hackintosh, it is very important to verify whether the necessary software has Intel CPU support on the OS X platform.

◆ Basic Technical Requirements for Hackintosh ◆

CPU:

The most suitable processors are Intel-based CPUs.

The reason is that Apple used Intel processors in all Mac devices until 2020.

Motherboard and BIOS Compatibility:

For macOS to work with a UEFI-based bootloader (Clover, OpenCore, etc.), the BIOS/UEFI version of the device must be compatible.

GPU and Drivers:

macOS supports only a limited number of GPUs (especially AMD Radeon series).

NVIDIA cards require older “web drivers.”

Disk Format:

The file system for macOS must be APFS or HFS+.

◆ Risks and Limitations of Hackintosh ◆

⚠ **Stability Issues:**

It is not guaranteed to work completely stable on every device.

In some cases, sound, Wi-Fi, Bluetooth, or GPU functions may not work.

⚠ **Update Risk:**

New macOS updates from Apple can sometimes make Hackintosh systems “unbootable.”

⚠️ **Legal Limitations:**

According to Apple’s license terms, macOS can only be used on Apple devices.

⚠️ **Software Compatibility:**

Some programs on Hackintosh systems work only on Intel-based macOS versions;

applications written for Apple Silicon (M1, M2, M3, M4) may be incompatible.

◆ Advantages of Hackintosh ◆

✓ It is a suitable alternative for trying the macOS ecosystem.

✓ It provides the ability to create test environments for iOS development (Xcode, Swift, etc.).

✓ It is possible to give relatively new life to older Intel-based PCs.

Additionally, the OS X operating system has been continuously developed throughout history and has continued its evolution to the present day.

Version	Version
2001	X 10.0
2007	X 10.5
2013	10.9
2016	S 10.12
2019	10.15
2020	11
2021	12
2022	13
2023	14
2024	15

Detailed Information About Mac Devices

◆ 1 ◆ **MacBook Air:**

This is the most affordable laptop class produced by Apple. Its physically very thin and lightweight design makes it ideal for daily use and portability. Since 2020, it has been equipped with M1, M2, M3, and M4 CPUs, making it one of the ideal options in the laptop world.

Thanks to its fanless design (without an active cooling system), it runs silently and offers around 20 hours of battery life. With these features, it is especially suitable for freelancers.

The base model comes with 8 GB RAM and 256 GB SSD; 24 GB RAM and 2 TB SSD options are also available. Despite being the base model, it can comfortably handle mid-level workloads.

◆ 2 ◆ **MacBook Pro:**

This is Apple's highest-segment laptop model. Unlike the MacBook Air, it has an active cooling system. In terms of power, stability, and portability, it is ideal for professional editors, video producers, sound engineers, and other creative professionals.

There are different models ranging from 16 GB to 128 GB RAM. M1, M2, M3, and M4 CPU options are available. SSD support ranges from 512 GB to 8 TB, and it is more expensive than the MacBook Air.

◆ 3 ◆ **iMac:**

This is Apple's all-in-one desktop computer model. The display, motherboard, CPU, RAM, and other components are combined in a single body. It comes with M1, M2, and M3 CPUs. RAM support ranges from 8 GB to 24 GB, and SSD support ranges from 256 GB to 2 TB. With its elegant design and high performance, it holds a special place in the tech world.

◆ 4 ◆ **Mac Mini:**

This is the smallest and most affordable desktop computer produced by Apple. It stands out with its energy efficiency and stability. It offers RAM support from 8 GB to 32 GB and SSD support from 256 GB to 2 TB. With its accessible price, it is ideal for home use and mid-level workloads.

◆ 5 ◆ **Mac Studio:**

This model is produced by Apple and is used for high-performance tasks and creative fields despite being relatively compact. It features a 76-core GPU and up to 192 GB of Unified Memory support.

◆ 6 ◆ **Mac Pro:**

This is Apple's highest-segment desktop computer and is physically large. It is designed for the highest workloads and is the most expensive model in the Mac lineup. Like a regular desktop, it has a modular structure, and many components can be replaced like a PC.

In M Ultra series models, up to 192 GB RAM and up to 8 TB SSD upgrades are possible. The 2019 Mac Pro models supported up to 1.5 TB of RAM because they were equipped with Intel Xeon CPUs, but this model is no longer produced. Mac Pro is ideal for heavy rendering, creative work, filmmaking, and 3D animation.

** ◆ Overall Summary Table:**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

scientific computing

What is Linux?

Richard Stallman launched the GNU Project in 1984 with the goal of creating a Unix-like operating system. The necessary tools for this project had been prepared, but the most critical component for an operating system to function — the kernel — was missing.

In 1991, the Linux kernel developed by Linus Torvalds made its first step into the technology world under the GPL (General Public License). Combined with Stallman's GNU project, the system took the name "GNU/Linux."

The main purpose behind the creation of Linux was to ensure stable and fast performance on devices with the lowest hardware specifications. Another important reason was to eliminate the restrictions caused by licensing and other artificial limitations in the technology world.

Today, Linux is the operating system with the largest market share in the server and supercomputer industry. Each Linux distribution is developed for specific purposes. Therefore, it is still not as widely known or popular among home users as Windows or macOS. Linux is mostly used in the IT world for special and technical purposes.

⚙ **Advantages of Linux**

✓ It is open source and free (at least many of its distributions).

✓ Offers a high level of security.

✓ Ideal for server and network operations.

✓ Provides excellent performance and stability.

✓ Can be adapted to many devices (thanks to being open source).

✓ Offers a wide tool ecosystem for developers and system administrators.

✓ Provides more privacy and confidentiality.

✓ Some distributions can run as portable (live USB without installing onto a new HDD or SSD).

⚠ **Relative Disadvantages of Linux**

✗ May appear complex for non-professional users.

✗ Some commercial software (Adobe, MS Office, etc.) still lacks official support.

✗ Gaming performance and support (especially compared to Windows) may be lower in some cases.

✗ Installation and driver compatibility can be difficult on some models.

✗ Requires storage devices (HDD, SSD) with fewer bad sectors; otherwise the operating system may crash.

600+ Distributions Developed on the Linux Kernel and Examples

- **Android:**

This operating system, which is the leader in the mobile and tablet market, was initially developed for camera devices, but since 2008 it has gained a special place in the mobile market. It is written using Java, Kotlin, C, JavaScript, Go, C++, Rust, and Assembly languages.

- **Ubuntu:**

One of the most popular Linux distributions, based on Debian. Actively developed and supported by Canonical Ltd. Ubuntu has versions for both server and desktop devices. It is one of the best-known Linux distributions among home users.

- **Lubuntu:**

Based on Ubuntu and designed for computers with lower specifications. Therefore, it works very stably and quickly.

- **Xubuntu:**

Based on Ubuntu and designed for computers with lower specifications. Requires slightly more resources than Lubuntu and primarily uses the Xfce desktop environment.

- **Debian:**

Built on the Linux kernel, Debian is one of the oldest and most universal distributions in the Linux world. Popular cybersecurity distributions such as Kali Linux and ParrotOS are based on Debian and have taken their place in today's world.

- **Fedora:**

Fedora Linux first emerged in 2003 as the continuation of the Red Hat Linux project and holds a special place in the Linux world.

- **Red Hat Enterprise Linux (RHEL):**

One of the oldest and strongest distributions belonging to the Red Hat Linux family. First released in 1994. Mainly used commercially by corporate companies and, unlike other distributions, it is paid.

- **Arch Linux:**

One of the oldest and strongest distributions in the Linux family. Though its usage is more complex for ordinary home users, nearly every function can be customized. Many distributions such as EndeavourOS and Garuda Linux are built on Arch Linux.

- **Kali Linux:**

Based on Debian and prepared by Offensive Security for cybersecurity and ethical hacking, it is one of the strongest distributions of the Linux family. Kali Linux comes with more than 600 tools such as Wireshark, Metasploit, and Nmap and holds a special place in the hacking world.

- **ParrotOS:**

Based on Debian and one of the strongest and leading operating systems in cybersecurity and ethical hacking within the Linux world. Very similar to Kali Linux but slightly more powerful. It includes more tools than Kali Linux and is more advanced in anonymity and hardware hacking.

- **Pardus:**

First developed and released in 2005 by the Turkish scientific and technological research institute TÜBİTAK. Used especially in educational institutions and by some home users in Turkey.

- **Pisi Linux:**

A distribution developed in 2011 based on Pardus Linux. Ideal for computers with lower specifications and mostly aimed at home users.

- **Wind River Linux:**

A distribution prepared as embedded for industrial devices. Has wide device support and is suitable for industrial use.

- **Linux Mint:**

Mainly developed for desktop and laptop computers. Offers a GUI (graphical user interface) similar to Windows, making it loved by home users. Also provides broad driver and software support. Based on Debian and Ubuntu.

- **Puppy Linux:**

One of the rare Linux distributions requiring very few resources. Can perform basic operating system functions with 128 MB RAM, 2.5 GB free hard disk space, and a basic 32–64 bit CPU.

- **Ubuntu Studio:**

Based on Debian/Ubuntu, designed essentially for music producers, DJs, video and film editing experts, painters, photographers, designers, podcasters, and content creators to set up a Linux-based audio/video studio. Therefore, it includes many pre-installed programs for these fields.

- **Parsix Linux:**

Based on Debian and designed to run on low-spec computers. Originates from Iran, one of the countries actively supporting Linux projects. Many Linux distributions today originate from this country.

- **Firefox OS:**

An operating system developed by Mozilla for mobile devices. It had a very simple and user-friendly graphical interface. Aimed to run web applications directly using web technologies such as HTML5, CSS, and JavaScript. However, it is no longer actively supported.

- **Astra Linux:**

Originating from Russia, its purpose is to increase security against the Windows operating system and prevent sensitive state data from leaking to third parties. Initially developed for government institutions but later released for home users as well. Known for running fast on low-spec computers. There are many Russian Linux distributions such

as ROSA Linux, ALT Linux, and RED OS.

- **Red Star OS:**

A national operating system developed by North Korea. Designed entirely for internal use and runs on an isolated “intranet.” Its main purpose is to eliminate dependency on foreign (especially Western) software and ensure internal data control. Global Internet access is limited with this operating system, and its appearance resembles macOS X.

Countries Providing the Most Support for Linux and Open Source (Updated List 2025)

№, Country, Main Projects / Support Examples, Support Level, Short Description

🇺🇸 **USA**,

"Red Hat, Fedora, Ubuntu (Canonical), Android (Google), AWS Linux, NASA, Meta AI, Microsoft (WSL, Azure Linux), Intel/AMD kernel optimizations",

"Global leader of open source. ~65% of kernel code is written by US companies."

🇨🇳 **China**,

"Kylin OS, Deepin, Unity Operating System (UOS), Huawei HarmonyOS Next (Linux kernel), OpenKylin, Alibaba Cloud Linux",

"National security strategy. Linux-based systems are developed at the state level."

🇫🇮 **Finland**,

"Linus Torvalds (creator of Linux), Jolla (Sailfish OS), Aalto & Helsinki Universities, TUX-era academic tradition",

"The country where Linux was born. Linus is still the main coordinator of the kernel."

🇩🇪 **Germany**,

"SUSE Linux Enterprise, openSUSE, Fraunhofer Institute, SAP HANA (Linux), BMW & Volkswagen (automotive systems)",

"Europe’s leader in open source. Although the Munich LiMux project stopped, corporate and scientific use is very strong."

🇷🇺 **Russia**,

"Astra Linux, ROSA Linux, ALT Linux, RED OS, BaseALT, military and state certification",

"Linux for national security. Mandatory use in state institutions and military structures."

🇮🇷 **Iran**,

"Sharif OS, Zamin OS, universities and research institutes, domestic development against sanctions",

"National Linux systems due to sanctions. Relatively limited but active usage exists."

🇫🇷 **France**,

"French Gendarmerie (Linux transition since 2005), state education sector (Ubuntu-based), CNES (space programs), Mageia",

"The largest Linux transition in government institutions. 90,000+ workstations run on Ubuntu."

🇧🇷 **Brazil**,

"Conectividade Brasil, Banco do Brasil (Linux servers), Serpro (state IT services), education projects",

"Linux in government offices and the banking sector. A national open source policy exists."

🇮🇳 **India**,

"BOSS Linux, IIT Madras (open source research), Android development, ISRO (space programs)",

"Support in state and education sectors. BOSS is still active."

🇯🇵 **Japan**,

"Sony (PlayStation Linux support), Fujitsu, NEC, Toyota & Honda (automobile OS), robotics technologies",

"Linux in industry and automotive. No national OS, but integration is very strong."

🇰🇷 **South Korea**,

"Samsung kernel contributions, LG WebOS (Smart TV), Harmonica OS (for education), NIPA open source initiatives",

"Asian leader in kernel development. TmaxOS failed, but Samsung is highly active."

🇹🇷 **Turkey**,

"Pardus Linux, TÜBİTAK ULAKBİM, Ministry of National Education (with EBA), transition in government institutions",

"National distribution strategy. Active usage in government and education sectors."

What is a Browser? and The New Generation Evolution of Browsers — The “Mini Operating System” Concept

A browser (Web Browser) is one of the fundamental software tools that enables users to access information on the internet. Its primary function is to read web pages (HTML, CSS, JavaScript), render them, and present them to the user as a graphical interface.

However, in recent years — especially starting from 2016–2017 — browsers have transformed from being simple information-reading tools into fully functional application platforms. After this period, thanks to the development of web technologies (HTML5, WebAssembly, WebRTC, PWA, and similar), browsers have gained capabilities similar to an operating system.

Today, it is possible to run many types of software without installing them separately, using only the browser. Now, functions like those below can be performed entirely through the browser:

Function	Technology / Example Enabling It
Photo editing	**Photopea, Pixlr, Canva** (completely web-based design tools)
Music production	**BandLab, Soundtrap, Amped Studio** (online **production** through the browser)
Video editing	**WebCodecs API, Clipchamp, WebGL**
Audio recording and editing	**Web Audio API and WebRTC** support
Real-time communication	**Camera and screen sharing** is possible with WebRTC and MediaRecorder API
3D modeling and games	**3D models and games** run inside the browser with WebGL and WebGPU technologies

Fundamental Technologies That Made This Evolution Possible:

Technology	Description and Role
HTML5	Enables multimedia (video, audio, graphics) to run

directly in the browser.
WebAssembly (WASM) Allows programs written in C, C++, Rust, and similar languages to run in the browser with high performance.
WebRTC (Real-Time Communication) Enables real-time communication such as camera, microphone, and screen sharing.
Service Workers Allows web applications to work in offline mode (for example, in PWA applications).
Progressive Web Apps (PWA) Creates websites that behave like apps (downloadable, notifications, offline support).
WebGPU / WebGL Enables 3D graphics and game engines to run directly inside the browser.

You can even learn your computer's screen refresh rate through a web browser, and there are special websites available for this purpose.

Historical Development Stages of Browsers

Year, Browser, Description

* **1990, WorldWideWeb (Nexus),** The first web browser. Created by Tim Berners-Lee at CERN. Later renamed Nexus.

* **1993, Mosaic,** The first browser to display text + images on the same page. Developed by NCSA.

* **1994, Netscape Navigator,** Played a key role in the mass popularization of the internet.

* **1995, Internet Explorer,** "Came bundled with Windows, was the market leader for a long time."

* **2003, Safari,** Apple's browser optimized for Mac.

* **2004, Mozilla Firefox,** "Open-source, secure, fast alternative."

* **2008, Google Chrome,** "Became the leader with speed, simplicity, and automatic updates."

* **2015, Microsoft Edge,** "Started with EdgeHTML, later switched to a Chromium-based version (late 2019)."

* **2019+, Brave, Vivaldi, Arc,** "Chromium-based browsers focused

on privacy/customization."

The Most Commonly Used Browsers Today:

1: LibreWolf — A Browser Designed for Security and Privacy

LibreWolf is an open-source browser developed based on Mozilla Firefox ESR (Extended Support Release),

but it maximizes the principles of user privacy, security, and freedom.

LibreWolf's Advantages in Terms of Technical Structure and Security:

Technical	**Detailed and Explanatory Version (with terminology)**
100% Open Source	LibreWolf is completely open source — meaning all of its source code is accessible to everyone through **GitLab**. This guarantees that there is no hidden telemetry (*telemetry → collecting user data in the background*) or tracking mechanism in the browser.
Telemetry and Tracking Removed	Although built on the Mozilla Firefox base, all **telemetry**, **data reporting**, **crash reporter**, and **health report** features have been completely removed. This ensures that user activities are never sent to any server.
RFP (Resist Fingerprinting)	The **RFP** feature prevents websites from collecting browser and device parameters (screen size, system language, fonts, etc.) to identify the user. As a result, everyone appears as the "same profile," making it difficult to create unique fingerprints.
First-Party Isolation	This feature separates cookies and storage data on a per-domain basis. That means **Facebook** or

Google cannot track users across other websites. It fundamentally solves the “cross-site tracking” problem.

Strict Site Isolation (isolated environment) and **Fission (site isolation)**. Each web page runs in a separate process — preventing malicious scripts from affecting other pages. This system is equivalent to the **Chrome sandbox** level.

The browser is optimized with the `librewolf.cfg` configuration and `user.js` file by default — containing more than 400 pre-enabled privacy and security settings (e.g., **WebRTC IP leak disabled**, **DNS over HTTPS**, **OCSP stapling**, etc.).

uBlock Origin are pre-installed in LibreWolf. Ads, tracking scripts, crypto-mining code, and fingerprinting scripts are automatically blocked.

All temporary data such as **cache**, **cookies**, **history**, and **form data** is automatically deleted. This prevents methods such as “persistent cookies” and “local storage tracking.”

DNS over HTTPS (DoH) and **OCSP stapling** are active in LibreWolf — ensuring the encryption of domain queries. This way, ISPs or third parties cannot see which websites the user visits.

Pocket, **Sponsored Tiles**, **Discovery Feed**, or other advertisement-based integrations. The interface is clean, fast, and simple.

Extended Support Release) base for each new version, meaning only stable and fully tested releases are used. This prevents experimental or risky features from being included.

Windows, **Linux**, and **macOS** systems. Especially on Linux, *AppArmor* and *seccomp* profile integration further increases security.

Optimized Performance: RAM and CPU usage is low. This improves performance especially on *low-end* (low-hardware) systems.

Highly configurable: Can be fully customized with `about:config` and `user.js` files — making LibreWolf ideal for both developers and security experts.

official GitLab repository and

secure package systems such as **Flatpak/Snap** — preventing modified or spyware-infected versions.

⚠ **Relative Weak Points:**

✖	Detailed Explanation
1.	**No "MozBlue Account"** — Firefox Sync is not fully compatible with Google and Microsoft services.
2.	**Some sites run unstable** — for example, Google Meet or Microsoft Teams sometimes run with "hard-coded" browser requirements.
3.	**Some extensions from Firefox** — Add-ons (especially those that use telemetry) are blocked by LibreWolf.

Mozilla Firefox — one of the most popular and reliable open-source projects in the browser world.

Developed by the Mozilla Foundation and its subsidiary Mozilla Corporation, Firefox is free and stands out with its privacy, security, and extensive customization options.

Firefox, which comes pre-installed on many Linux distributions, provides strong integration with security testing and pentest tools (for example, Burp Suite).

Firefox offers stable operation, rich graphical rendering, strong privacy protection, and synchronization between devices through Firefox Sync — meaning that when logged in with the same email and password, bookmarks, history, passwords, and other user data are automatically transferred to your new device.

This and many other features make Firefox one of the leading browsers.

Firefox’s core advantages in terms of Technical Structure and Security:

Technical Advantage	Description
Mozilla Project	The entire codebase is open (MPL 2.0). Anyone can inspect, modify, and share it.
Modern Architecture	Quantum Project: With WebRender, Stylo, and Quantum Flow, it is a fast and low-resource-consuming browser.
WebRender (GPU rendering)	Rendering engine powered by the GPU (graphics card). Provides smooth animations and low CPU usage.
Gecko Engine	The core engine that runs HTML, CSS, and JavaScript fully according to standards.
Multi-process architecture (e10s)	Each tab runs in a separate process. Reduces freeze and crash risks.
Firefox Sync	Bookmarks, passwords, history, and extensions are synchronized between devices in encrypted form.
Enhanced Tracking Protection	Blocks cross-site trackers, cryptominers, and third-party cookies.
Total Cookie Protection (dFPI)	Each site’s cookies are kept separate. Cross-site tracking becomes impossible.
WebExtensions API	Provides a secure, standard, and Chrome-compatible programming interface for extensions.
Components written in Rust	Components such as CSS engine, MP4 parser — developed in the Rust language for memory safety and performance.
Parallel CSS Engine (Parallel Style Engine)	Processes CSS in parallel on multi-core processors. Pages load faster.
Site Isolation	Each site is loaded in a separate process. Security and privacy are maximized.
Parallel DOM	Processes the DOM structure of web pages in a multi-process and asynchronous way.
Sandboxing	Each process runs inside a “sandbox.” Malicious code cannot access the system.
HTTPS-Only Mode	Allows only secure (HTTPS) connections. Prevents data theft.
DNS over HTTPS (DoH)	DNS queries are sent through an encrypted channel. Internet providers cannot track them.
Picture-in-Picture (PiP)	Allows videos to play in a small window outside the browser.
Multi-Account Containers	Keeps different accounts (work, personal, etc.) in separate “containers.”
Manifest V3 support	Extensions are supported for the same

standard as Chrome. More than 10,000 extensions are available.
Memory Optimizer 2.0 and “Quantum Flow” reduce memory leaks to a minimum.
Firefox Extensions: uBlock Origin, AdGuard AdBlocker, Dark Reader.
Categories: Privacy & Security, Tab Management. Security checks: AMO Review process (code review, permission system); open source, Manifest V2 and V3 support.

Additionally, **Mozilla Thunderbird** is a free and open-source email client developed by the Mozilla Foundation.

This program can connect to Gmail, Yahoo, Outlook, and other email services using IMAP and POP3 protocols.

Thunderbird allows users to read emails offline, manage multiple accounts, filter spam, perform encryption (PGP, S/MIME), and expand functionality through add-ons.

In short, it is a powerful email management program for the desktop.

Furthermore, Firefox’s official store provides thousands of themes and add-ons (programs added to the browser) that improve performance. These features make Firefox one of the leading products in the browser world.

However, Firefox can only run on Windows, Linux, and Mac OS X platforms; meaning it cannot be officially run on mobile devices.

✓ **Complete, Unabridged English Translation (Zero Loss of Content)**

Google Chrome:

Google Chrome is a fast, multi-process, Chromium-based web browser developed by Google.

It was first released on September 2, 2008 for Windows, and later made available on macOS, Linux, Android, and iOS platforms.

As of 2025, Chrome is the most widely used browser worldwide (60% + market share).

However, this browser is heavily criticized by many users globally. The main reason is that its privacy policy is weak for most users.

In addition, Chrome demands more resources such as CPU and RAM compared to all competing browsers. It also does not operate as stably as Firefox; despite this, it uses higher system resources than Firefox.

Google Chrome Technical Engines and Architecture:

Component	Description (English Translation)
Blink (Rendering Engine)	The rendering engine that generates the visual output of HTML, CSS, and JavaScript. It is the core part of the Chromium project (developed after being forked from WebKit).
V8 (JavaScript Engine)	The engine that executes JavaScript code quickly via JIT (Just-In-Time) compilation. Works with Ignition (interpreter) + TurboFan (optimization engine). It does not perform “real-time translation”; it performs compilation and optimization.
Multi-process Architecture	Each tab runs in a separate process → if one tab crashes, the others remain unaffected. Plugins (NPAPI) are no longer supported (disabled since 2015). Currently, only WebExtensions are used.
Sandboxing	Each tab is isolated inside a “sandbox.” Malicious code cannot penetrate into the system (implemented using Job Objects on Windows, seccomp on Linux, and seatbelt on macOS).
WebAssembly (WASM)	A low-level binary format that enables high-performance applications (games, video rendering, apps) to run in the browser. Compiled from languages like C, C++, and Rust.
GPU Acceleration	Graphics tasks (CSS animations, video, WebGL) are offloaded to the GPU → provides smoother and faster performance.
Manifest V3	The new platform for extensions: improves security and energy efficiency. AdBlock-like tools are limited — DeclarativeNetRequest API allows a maximum of 30,000 rules; dynamic filters are prohibited. However, versions such as uBlock Origin Lite still work.

Technical Advantages:

No.	Feature	Description
1	**V8 JavaScript Engine**	One of the fastest JS engines in the world; written in C++ by Google.
2	**Multi-process System**	The browser does not freeze because each tab and extension runs in an independent process.
3	**Sandbox**	Malicious sites cannot access system files.
4	**Blink Rendering Engine**	Chrome's rendering performance is very fast and accurate.
5	**WebAssembly Support**	Heavy applications (e.g., AutoCAD Web, Unity Web games) run smoothly in the browser.
6	**Hardware Acceleration**	Videos and animations are displayed more smoothly via the GPU.
7	**Chrome Sync (synchronization)**	Passwords, history, tabs, and extensions sync across devices using a Google account.
8	**Tab Crash and Memory Management**	Only the crashed tab closes instead of the entire browser.
9	**Security & Safe Browsing**	Warns against phishing and malicious websites.
10	**Developer Tools (DevTools)**	One of the most powerful built-in debugging and analysis tools for web developers.
11	**WebGPU and WebGL 2.0 Support**	Provides high-performance support for 3D and graphics applications.
12	**Cross-Platform Compatibility**	Offers the same experience on Windows, macOS, Linux, Android, and iOS.

Weaknesses and Criticisms:

No.	Problem	Explanation and Impact
1	**High RAM Usage**	Consumes a large amount of memory because each tab and process runs separately.
2	**Privacy Issues**	Google collects telemetry and tracking data. Criticized in terms of privacy.
3	**Reduced Functionality of Ad Blockers**	Manifest V3 restrictions limit the capabilities of ad blockers (AdBlock, uBlock Origin).
4	**Closed-Source Code**	Although Chromium is open source, Chrome itself is not fully open.
5	**Battery Consumption**	Causes laptops to drain battery faster.
6	**Privacy Policy**	Chrome Sync synchronizes too much personal data to the Google account.
7	**Integration with Google**	Integrated with Google's advertising ecosystem; user interests are secondary.

Extensions and Store

Chrome Web Store offers more than 350,000 extensions (add-ons) and thousands of themes.

Google Chrome also supports Windows, Linux, Mac OS X, and Android.

Brave:

Brave Browser is an open-source, Chromium-based web browser, but without ads and without trackers.

The main purpose of Brave is to protect user privacy, increase speed, and share advertising revenue with the user.

In short, Brave is not only a browser — it is also an ecosystem that combines blockchain technology and crypto economics (Basic Attention Token — BAT).

Technical Architecture

Description
Chromium Base — Google Chrome's open-source Chromium platform.
Blink Engine — visual interpretation of HTML, CSS, and JS (same engine as Chrome).
V8 JavaScript Engine — executes JS code with high performance using JIT technology.
Brave-specific — additional security and privacy modules: Shields, Rewards, Wallet, etc.
BAT (Basic Attention Token) — the token of the advertising system (ERC-20, built on Ethereum).
Brave Sync — peer-to-peer (P2P) synchronization — does not require a Google account.
Brave Shields — ad and tracker blocking system.
Tor Integration — complete anonymization of IP and

activities.

Technical Advantages

No.	Technical Description (English Translation)
1	**Ads & Trackers Blocking** — automatically blocked using the Brave Shields module.
2	**Built-in Tor Browser** — hides your IP address, provides completely anonymous browsing.
3	**BAT Reward System** — possibility to earn Basic Attention Token (BAT) by viewing ads.
4	**Crypto Wallet** — Ethereum, Solana, Bitcoin; an alternative to MetaMask.
5	**HTTPS Everywhere** — forces the use of HTTPS — security is increased.
6	**Fingerprinting Randomization** — browser fingerprint is randomized, making tracking impossible.
7	**Web3 Support** — integration with DApps (decentralized applications) and NFTs.
8	**Brave Search** — search engine that does not track users and is an alternative to Google.
9	**Brave Talk** — encrypted video calling service (based on Jitsi).
10	**Brave Leo** — AI assistant integrated with OpenAI and Brave's own AI model.
11	**Sync v2** — peer-to-peer synchronization (decentralized), without a Google account.
12	**Energy & Efficiency** — low RAM and energy consumption compared to Chrome.
13	**Cross-platform** — Windows, macOS, Linux, Android, and iOS.
14	**Private Ads System** — ads are processed within the device, not sent to the server (local analysis).
15	**Built-in Script Blocking** — malicious scripts (cryptominers, pop-ups) are blocked.

Relative Weak Points and Limitations

No.	Weak Point Description
1	**Some sites detect Shields** — they block some site functions.

2. **Extensions** – Although Chrome extensions work, some are not fully compatible with Brave's APIs.
3. **BAT ecosystem** – Limited funding and **region-specific limitations**.
4. **Sync** – Brave Sync is **less reliable** than Google servers, delays can occur.
5. **Tor mode** – Not as **secure or stable** as Tor Browser.
6. **AI and Brave Leo** – **Region-limited** countries.
7. **Does not offer cross-device synchronization** capabilities like Firefox.
8. **Closed-source** – Some parts of Brave are not open-source, and BAT rewards system are controlled by Brave (not fully decentralized).

Brave supports many Chrome Web Store extensions because it is Chromium-based.

Additionally, Brave can be used on Windows, Mac OS X, Linux, Android, and iOS platforms.

Furthermore, here is brief information about Chromium-based browsers:

Vivaldi:

Feature	**Information**
Name and slogan	"Your personalized, customizable professional browser" *(a description adopted by users; official slogan: "A browser for our friends")*
Founder	**Jon Stephenson von Tetzchner** – co-founder and former CEO of *Opera Software* (1995–2011)
Developing company	**Vivaldi Technologies AS** *(founded in 2013)*
First release	April 27, 2016 – Vivaldi 1.0
Engine	**Blink (Render)** + **V8 (JavaScript)** – *Chromium-based (Google modules removed, custom UI added)*
Programming language	**C++** (core, performance), **JavaScript** (*React.js-based UI*), **CSS**, **TypeScript**, **HTML**
Main platforms	**Windows**, **macOS**, **Linux**, **Android** *(no iOS version)*

Open source? Chromium core is open source, but the Vivaldi UI and special features are closed source*

Technical and functional features:

Feature	Description
Interface customization	**Extremely flexible tab positioning, button sizes**, color palette, fonts, and shortcuts can be fully customized.
Built-in tools	Includes an integrated **email client (Vivaldi Mail**), an RSS reader, and a calendar (**Calendar**) within the browser.
Security and privacy	**Built-in tracker and ad blocking. Minimal dependence on Google services.
Tab management	Advanced tab handling such as tab stacking, split-view screen, and tab grouping.
Resource consumption	**Although Chromium-based, extensive features can lead to relatively high RAM usage on some systems.
Synchronization	**Bookmarks, history, tabs, and settings are synced across devices with a Vivaldi account using encrypted synchronization.

OPERA:

Opera – developed in 1995 by the Norway-based company Opera Software ASA.

Initial engine: **Presto (1995–2013).**

Since 2013: **Blink (Chromium-based).**

Since 2016: under the control of the China-based company **Opera Limited**.

Platforms: **Windows, macOS, Linux, Android, iOS.**

Technical and functional features:

Feature **Description**

Built-in VPN Opera provides an encrypted tunnel (VPN) through its own servers – AES-256 encryption, IP masking, 15+ virtual locations (Europe, America, Asia). The free VPN is enabled by default; VPN Pro (premium) is faster and offers 100+ locations.

Built-in Ad blocker and tracker protection Ad blocker based on EasyList/EasyPrivacy and includes crypto-mining and pop-up blocking. No additional extension is needed – enabled via Settings → Privacy & Security.

Opera GX (for gamers) Special browser version for gamers – RAM and CPU limiters (GX Control Panel), RGB themes, game news panel (integration with Twitch, Discord, Steam), Aria AI (for game strategies).

Flow feature Encrypted end-to-end sharing of files, links, notes, and images between mobile Opera (or Opera Mini) and desktop Opera – with My Flow offering personal storage space.

Sidebar Apps such as WhatsApp, Telegram, Facebook Messenger, VK, Discord, Slack, Bluesky can run directly inside the browser – they can be pinned and show notifications.

Turbo mode Speeds up loading on slow internet connections by compressing pages – mainly active in Opera Mini; in standard Opera it has been replaced with Data Saving mode (still available in Settings).

Microsoft Edge:

Technical Information **Description**

Developer/Owner Microsoft Corporation Microsoft Edge is developed and maintained by Microsoft Corporation (as of 2025, this remains the case).

First release 2015 (EdgeHTML-based). Chromium-based since 2020 – First release: July 29, 2015 (with Windows 10, using the EdgeHTML engine). Chromium transition: January 2020 (stable release, using the Blink engine).

Engine Blink (renderer engine) + V8 (JavaScript engine) – Chromium-based (since 2020).

Platforms Windows (10/11), macOS, Linux (Ubuntu, Debian, etc.), Android, iOS – full support across all platforms (as of 2025, last two iOS versions).

Technical and functional features:

Feature	Description
AI Integration	**Microsoft Copilot / Bing AI** – AI assistant built into the browser (similar to ChatGPT).
Performance	**Sleeping Tabs / Efficiency Mode** – “Efficiency Mode” reduce RAM and CPU usage of open tabs.
Security	**SmartScreen Filter**, sandbox mode, HTTPS-only mode, and a built-in password manager.
Sync	**Sync tabs, history, and extensions** sync across devices.
Extensions	**Extensions from the Chrome Web Store** work flawlessly on Edge.
Enterprise Management	**Enterprise Mode, Group Policy** and Azure AD integration for corporate environments.

Additionally, since browsers like **Vivaldi, Opera, and Edge** are Chromium-based, most extensions from the **Chrome Web Store** can run smoothly on **Vivaldi, Opera, and Edge**.

Most Common Terms in the Computer World and Their Detailed Explanations:

What Is Portable?

Portable at the Software Level:

Portable programs are applications that can run without being installed on a computer and store all necessary files and configurations within their own folder.

Additionally, many computer games can also be made portable by moving all system files and configurations stored in their main folder to a USB Flash Drive, Portable SSD, HDD connected through a special converter adapter to a USB port, NVMe, SATA SSD, SD Card, Micro SD Card, or optical DVD devices.

(For example: Moving the main folder — located inside the Program

Files directory in the C drive on a Windows 10 operating system — of any game that contains all required files and configurations to any external storage device.)

Some operating systems can also run in portable mode through storage devices such as USB Flash Drives without installing them on an internal HDD or SSD by using Live CD mode (running live).

Examples: Linux Mint, Lubuntu, Kali Linux Live Boot version, Bliss OS, Windows To Go.

This allows you to run the relevant software directly when you switch to a new device or use another computer, without downloading the setup file from the internet or going through an installation process (as long as the operating system platform is the same).

Additional Advantages:

• Easy transfer of programs and games from one device to another.

• Minimal (or no) modification to the system registry.

• Ideal for testing and for security purposes (sandbox or isolated environment).

• Easy to preserve the same program configuration across different devices.

• Saves time since there is no installation phase and places less load on system resources.

Relative Limitations:

• Some programs may not offer full functionality when run from an external device. (Not valid for all portable programs.)

• Issues may occur in portable mode when system libraries or special drivers are required. (But not valid for most portable programs.)

• Performance may decrease slightly in high-performance applications. (This difference may be minimally noticeable in some games and programs, but in most cases the user cannot notice it.)

Portable at the Hardware Level:

In general, many internal storage devices — such as HDD, SATA SSD, NVMe SSD, M.2 SATA SSD — can be made portable using converter tools.

What Is Virtualization?

Virtualization — is the technology that allows one or more operating systems to run through software capable of virtualization such as VMWare, VirtualBox, Qemu, Hyper-V on an operating system running on a physical computer.

To run an operating system on a virtual machine, a portion of resources from the physical system (CPU, RAM, HDD/SSD, GPU, Network, etc.) is virtually allocated to the virtual machine to run that operating system.

Simply put: An ecosystem that can run one or more operating systems inside a host operating system.

Advantages of Virtualization:

• Ability to run multiple operating systems on a physical device (if the computer has enough resources).

• Testing certain viruses and observing what changes the virus makes on the device (mostly done by cybersecurity experts).

• If a software is not supported on your main operating system, you can install on the virtual machine an operating system that supports that software and run it there.

• Ability to run the required software on a specific operating system on a server 24/7.

Additionally, it is important to know whether the computer's CPU supports virtualization technology to perform these tasks.

This setting must also be enabled through the BIOS/UEFI.

Popular Virtualization Software:

Programs

Oracle VM VirtualBox** – Optional, free, large user base

VMware Workstation** – Optional virtual machine program

KVM** – Powerful hypervisor for Linux

Proxmox VE** – Virtualization system for servers

Microsoft Hyper-V** – Hypervisor solution

What Is an Emulator and What Is the Difference Between an Emulator and a Virtual Machine?

An **emulator** is software that mimics the behavior of a system (hardware + software architecture) in a way that closely resembles the real device, allowing it to run on another operating system.

The most fundamental difference of an emulator is that it does **not** require separate virtualization or installation of the operating

system running on that device.

This is because an emulator contains within itself both the virtualization required to mimic the device **and** the operating system that runs on it.

Emulators are commonly used to emulate Android and iOS devices.

Additionally, there are separate emulators used to emulate PlayStation and similar devices.

Some examples of Android emulators include:

* BlueStacks

* KoPlayer

* LDPlayer

* MEmu Play

* NoxPlayer

Moreover, many of these emulators support **Pie-64** and **Nougat 32-bit** architectures.

This allows both old and new applications to run smoothly.

What Is x64?

x64 (64-bit) is the name of an architecture used for CPUs. CPUs with this architecture were first produced by AMD in **2003**, and implemented by Intel in **2004** in Intel Xeon CPUs.

The x64 architecture was developed as a continuation of the 32-bit (x86) architecture, and thanks to 64-bit CPUs, it provides more computing power, higher RAM support, and faster operation.

Additionally, most actively used computers worldwide run on x64 (64-bit) architecture CPUs.

Main advantages of CPUs with x64 architecture:

* 64-bit CPUs have much higher data processing power compared to 32-bit CPUs.

* **More RAM support** — 32-bit CPUs are limited to a maximum of **4 GB RAM**.

This means that if you install a 32-bit operating system on a device with a 64-bit CPU, the computer will boot normally and perform many functions, but due to the 4 GB RAM limit, it will not recognize or actively use more than 4 GB of RAM, even if your RAM modules exceed 4 GB.

* Theoretical maximum RAM support for 64-bit CPUs is **16 exabytes** (16,000,000,000 GB).

This allows servers, workstations, and supercomputers to use thousands of gigabytes of RAM.

However, in the real world, for a normal computer, these limits depend on the CPU architecture and the motherboard's maximum RAM support.

* 64-bit systems can run both **32-bit and 64-bit applications and operating systems**, whereas 32-bit systems can run **only 32-bit** applications and operating systems.

(We can explain this as follows: You can fit a 32-square-meter object into a 64-square-meter space, but you cannot fit a 64-square-meter object into a 32-square-meter space.)

In short, this gives you the ability to run both old-generation and new-generation applications and operating systems on your computer.

What Is a Terminal?

A **terminal** is an interface between the computer's operating system and the user; it is an environment where commands are entered through the command line (Command Line Interface, CLI).

The terminal comes pre-installed and can be run on many operating systems, such as Windows, macOS, and many Linux distributions.

Through a terminal, you can perform many of the operations you do on a GUI — and even more.

The reason is that the terminal communicates directly with the operating system.

In short: The terminal allows you to execute many commands on the operating system in the shortest way possible.

What can be done with a terminal in an operating system?

And some examples:

Collecting information about the internet network with the terminal

For example: IP address, MAC address, subnet mask address, IPv4 address, Link-local IPv6 address, and much more.

It is also possible to determine whether the USB WiFi adapter used to

provide communication between the computer and the WiFi modem supports monitor mode.

(This feature is especially used in cyber security for test-purpose WiFi attacks, analysis, and cracking WiFi passwords.)

Repairing corrupted system files with the terminal

sfc /scannow — Detects and repairs corrupted system files in Windows.

chkdsk — Detects and fixes disk errors (bad sectors, file system errors).

File and folder system management with the terminal

Even if the operating system does not open in GUI mode (e.g., during system failure or while installing a new operating system), it is possible to access the storage devices in the computer and:

* view folders

* view files

* copy files

* move files

* delete files

System management with the terminal

Using Windows as an example:

shutdown -s -t X — Automatically shuts down the computer after X seconds.

Restarting

Logging out

and other management functions are possible through the terminal.

Performing Task Manager functions through the terminal

Without opening the GUI:

tasklist /v — Displays active processes and running programs.

taskkill /f /im program.exe — Force-closes a frozen or unresponsive program.

Viewing hidden files and folders through the terminal

Windows CMD:

dir /a — Displays all hidden + visible files.

dir /a:h — Displays only hidden files.

PowerShell:

Get-ChildItem -Force

Note: Deleting hidden system files is very risky and may cause system failure.

Bypassing the mandatory internet and Microsoft account requirement during Windows installation

During Windows 11 installation:

Shift + F10 — opens the terminal.

Type **oobe\bypassnro** → the computer restarts → allows installation to continue without internet and a Microsoft account.

(This method currently works, but it may be disabled by Microsoft in the future.)

Measuring computer hardware performance via the terminal

Windows CMD:

winsat prepop — starts performance tests.

Then in PowerShell:

Get-CimInstance Win32_WinSat — provides information about RAM, CPU, Disk, and Graphics performance.

Note: For more accurate results, CMD and PowerShell should be opened with “Run as Administrator.”

Library management for developers via the terminal

Python example:

pip install librosa — installs a library.

pip uninstall librosa — removes a library.

python main.py — runs a Python program.

And there are countless more operations that can be performed through the terminal.

Analyzing laptop battery health with the terminal

powercfg -energy — generates a comprehensive report about the battery’s energy usage.

Report location:

C:\WINDOWS\system32\energy-report.html

After opening this file in a browser, the user can analyze the real battery condition using mathematical calculations.

Terminal on mobile devices

On Android:

Termux — a terminal environment installed manually.

It can be used for various purposes and has extensive capabilities.

What Is BIOS?

BIOS stands for **Basic Input Output System**, and it is located on a chip on the motherboard; this chip is usually black or brown in color.

BIOS is the first software that runs when the computer is powered on, and therefore it is considered the “soul” of a computer.

When the computer starts, the BIOS tests whether all components are working properly and checks system compatibility. If everything is fine, shortly afterward you will see the boot screen of the operating system installed on the computer.

BIOS also enables data exchange between components while the computer is booting.

If there is a malfunction in one or more computer parts, the BIOS analyzes this and informs the user.

What Is UEFI?

UEFI stands for **Unified Extensible Firmware Interface**, and in many modern computer systems, it replaces **Legacy BIOS** (Traditional BIOS). In terms of security and functionality, it is a more advanced version of BIOS.

UEFI performs all the functions that BIOS does — and even more.

UEFI BIOS on modern gaming computers has a richer and more extensive graphical interface.

It is also possible to manage settings and navigate menus using a keyboard + mouse or touchpad.

The BIOS found on older-generation computers, however, allows settings to be managed only with the keyboard and has a text-based menu.

Since most users will encounter UEFI in real life on modern computers, we will continue our explanation using UEFI.

Core Functions Managed by UEFI

Checking Components During Startup

When the computer starts, it checks whether components like the CPU, RAM, and storage device are functioning properly.

Boot Selection

It allows choosing which storage device (HDD, SATA SSD, M.2 SATA SSD, NVMe SSD, USB Flash Drive) the operating system will boot from during startup.

System Settings

Through UEFI system settings, it is possible to change the frequency of components such as the CPU and RAM, as well as other basic system parameters.

This allows components to operate at the highest possible frequency.

Additionally, increasing CPU voltage to boost performance is also possible.

Secure Boot

With Secure Boot enabled, malicious software is prevented from running before the operating system loads.

If this setting is active, the system allows only trusted and signed operating systems to be booted.

Fan and Cooling Control

It provides better cooling performance by adjusting the rotation speeds of the CPU and other fans.

Wake-on-LAN

By connecting to the computer over a Wi-Fi router or LAN cable, it allows sending a signal from a phone or tablet over the local network

to power on the device or wake it from sleep mode without physically touching it.

TPM (Trusted Platform Module)

The TPM setting enables the Platform Trust Module and supports encryption tools such as BitLocker.

TPM is a physical, hardware-based security chip that improves computer security by storing encryption keys and sensitive data.

TPM 2.0 is generally enabled for installing the Windows 11 operating system.

Network Boot

It enables booting the operating system over a network instead of using a storage device (like HDD, SSD, USB Flash Drive).

This method is commonly used by companies and institutions.

Additionally, by connecting a specially configured computer to another via a LAN cable, the operating system can be booted and installed on the other computer through data transfer.

Firmware Updates

Updating BIOS/UEFI is possible without an operating system.

This is done to ensure full compatibility between the system and newly added components.

However, this process should only be performed by experienced users.

Because if a power outage or any problem occurs during the firmware update, it can cause very risky consequences for the device.

Temperature Monitoring

Temperature can be monitored through sensors on the CPU and motherboard.

Voltage Monitoring

The electrical voltages of components such as the CPU, RAM, and PCIe can be monitored.

Fan RPM Monitoring

The RPM (revolutions per minute) of cooling fans connected to the motherboard can be measured.

VT-x / AMD-V Technology

Provides virtualization support on the CPU for virtual machines (e.g., VirtualBox, VMware).

It only enables CPU support; creating the virtual machine is done within the operating system.

IOMMU / VT-d

Enables pass-through support for PCIe devices in virtual machines. For example, a physical PCIe device (network card, graphics card, sound card, etc.) can be assigned directly to the relevant virtual machine, allowing the VM to use the device as if it were managing it natively.

This improves device performance and reduces latency in virtualization environments. For example, with GPU passthrough, the VM can use the graphics card directly with high performance.

What Is Task Manager?

Task Manager is a program in the Windows operating system that essentially shows and manages running processes, programs, background services, and the usage of system resources in real time.

Additionally, you can see the CPU, RAM, GPU (Integrated or Dedicated), HDD, SATA SSD, M.2 SSD, NVMe SSD, Network (Internet Network), and NPU usage percentages of the Windows operating system and all programs running on it, background processes, drivers, and in short, all active processes running on the operating system.

In addition, Task Manager can provide extensive information about the hardware (PC components) in the computer, and by pressing **Ctrl + Shift + Esc** together, you can monitor all running processes in Task Manager.

Basic Information That Task Manager Provides About the CPU:

The CPU's manufacturer, brand, generation, the performance indicator at the end of the CPU's full model name, whether it supports overclocking, whether it has an integrated graphics module (letters such as K, KF, H, HX, U in Intel CPUs), and the CPU’s base frequency.

How much of the CPU resources are being used at that moment (as a percentage), maximum output speed, the number of operations it is performing at that moment, the number of threads, identifiers, and the CPU’s total uptime (in days or hours).

Task Manager provides information about the physical properties of the CPU; for example, the number of CPU sockets (how many sockets are available on the motherboard to install CPUs and how many CPUs

are physically running in these sockets).

The number of physical cores on the CPU, the number of threads (virtual cores – new thread count), and whether virtualization is enabled can be seen.

L1, L2, L3 cache amounts in KB, MB, or GB. Generally, L3 is in GB and is available only in certain special AMD CPUs.

In the Windows 11 operating system, with broader monitoring, it is possible to separately see the load amount on all physical cores and threads of the CPU.

Basic Information That Task Manager Provides About RAM:

Information about the physical RAM on the device.

Total capacity of the RAM in MB, GB, or TB.

Whether it is DDR1, DDR2, DDR3, DDR4, or DDR5.

How much of the RAM is actively being used and how much is compressed.

Available free RAM amount.

Cache pool reserved for disk, and non-cached amount.

The speed of the RAM (in MHz).

Total RAM slot count on the motherboard and how many slots are populated.

The physical form factor of the RAM: **DIMM**, **SODIMM** (DIMM is generally used in desktop computers, while SODIMM is smaller and used in laptops).

How much of the RAM is reserved for hardware (hardware reserved).

Basic Information That Task Manager Provides About the Storage Device:

The exact brand and model of the storage device.

Total capacity in GB or TB.

Total formatted area reserved during OS installation.

Whether the storage device is SATA SSD, M.2 SATA SSD, NVMe SSD, or RAID HDD (especially in Windows 11).

Whether it is the main storage device that contains the operating system.

Whether it has disk caching.

The usage percentage of the storage device.

The response time of the storage device (usually in milliseconds for HDDs).

Read and write speed.

Basic Information That Task Manager Provides About the Internet Network:

The exact brand and model of the Wi-Fi USB adapter connected to the internet.

The amount of packets sent by the Wi-Fi network (KB/second).

The amount of packets received by the Wi-Fi network (KB/second).

Internet connection type (e.g., Wi-Fi, LAN, etc.).

SSID information (name of the connected network).

DNS network name (e.g., STELFIBER).

Connection standard (e.g., 802.11n).

IPv4 (e.g., 192.168.1.14) and IPv6 address.

Signal strength displayed with a small graphic.

Information That Task Manager Provides About the Graphics Card:

The manufacturer and exact brand/model of the graphics card.

How much load is being used in each section of the graphics card: 3D, Copy, Video Encode, Video Decode.

Dedicated GPU memory usage displayed with a live graph.

Shared GPU memory usage displayed with a live graph.

A live percentage showing how much of the total graphics card power is being used.

The temperature of the graphics card displayed as a percentage.

The VRAM amount of the dedicated graphics card, shared VRAM amount, and total graphics memory.

Driver version, driver installation date, DirectX version, the physical slot the graphics card is installed in, and hardware reserved memory.

What Is MBR?

MBR (Master Boot Record) is an information system located in the first sector of a storage device that determines how a computer will boot (start the operating system) and how it will locate the partitions on the hard disk.

The MBR contains the code required for the boot process and the

partition table information.

This is the essential data that enables the operating system to start first on a computer.

History of the MBR

The MBR (Master Boot Record) was first introduced by IBM in 1983 with PC DOS 2.0.

This technology contains information about the storage device's partitions and the code that initiates the boot process.

The MBR is an older disk partitioning system and has been in use since 1983.

At the beginning of the disk, in sector 0, the MBR information is located; here, the number of partitions on the disk, their sizes, and their locations are recorded.

At the same time, a small program (bootloader) is stored here, and this program manages how the system will be loaded. This program enables the operating system to transition into the second stage.

Most computer users recognize this term when installing an operating system or preparing a bootable USB, often through a program called **Rufus**, which writes the ISO file of an operating system to a USB drive.

Sector 0 at the Beginning of the Disk

In the very beginning of the disk, in the part known as sector 0, the following information is stored:

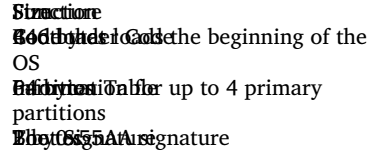
* A small program that determines how the disk will be loaded (Bootloader)

* A table indicating how many partitions exist on the disk

* The size and location of each partition

Structure of MBR Sector 0

MBR sector 0 has a structure of **512 bytes**.



Limitations:

* Maximum disk size: **2 TB**

* Maximum number of partitions: **4 Primary**

* No boot security

* If damaged, the disk may fail to boot entirely (because the initial sector is unique)

What Is GPT?

GPT (GUID Partition Table) is a much more modern and secure disk

partitioning system that works together with UEFI.

Unlike MBR, a GPT disk stores important data not in just one location but in multiple locations. For this reason, the risk of corruption is much lower, it is more secure, and it supports much larger storage capacities.

A GPT disk consists of the following structure:

GPT Structure

Protective MBR — Makes the disk appear “full” to older systems for protection

Primary GPT Header — Contains disk metadata (location, number, and structure of partitions)

GPT Partition Entries — Define type, attributes, and unique 128-bit identifier for each partition

Backup GPT Header — Stored at the end of the disk — provides redundancy

Advantages:

* Maximum disk size: **9.4 ZB (Zettabyte)**

* Up to **128 partitions** (standard on Windows)

* Redundant structure for corruption protection

* **CRC32** verification — detects corrupted data

* Excellent compatibility with UEFI

* Supports Secure Boot and modern boot mechanisms

Full Comparison Table Between MBR and GPT

Feature	MBR	GPT
Release year	1983	2008
Maximum disk size	2 TB	9.4 ZB (Zettabyte)
Number of partitions	4 primary (or 3 + 1 extended)	128 (standard on Windows)
Boot mode	Legacy BIOS	Modern (UEFI) BIOS

Maximum disk size	2 TB (practically unlimited)
Maximum partitions	4 primary (Windows), more are also possible
Boot mechanism	Legacy BIOS	UEFI
Boot (Secure Boot)	No	Yes
Backup (GPT header)	No	Yes
Corruption risk	Very high	Very low
CRC32 verification	No	Yes
EFI System Partition	No	Yes
32-bit UEFI	No	Yes
Hybrid BIOS compatibility	Yes	No
Boot speed	Slow	Fast (thanks to UEFI)
OS support	Supported by all OSes, Linux — broad support	
64-bit UEFI support	No	Yes, 32-bit UEFI support also possible

When Is MBR Used?

* Older generation computers (those using Legacy BIOS)

* HDDs and SATA SSDs smaller than 2 TB

* Very old Windows versions (Windows XP, Vista, Windows 7, 8.1, 10)

When Is GPT Used?

* Windows 10/11, Linux, macOS, and others

* Mostly NVMe SSDs, M.2 drives, large HDDs

* When Secure Boot is used

* On systems where UEFI is enabled

What Is a File System?

A file system is the structure that determines how data (files and folders) will be stored and managed in a computer's memory.

In other words, the file system defines how data is organized and located on disks, SSDs, USB flash drives, and other storage devices.

Without a file system, a computer cannot manage data effectively because:

* It wouldn't know where to write data,

* It wouldn't be able to find where information is located,

* It would be impossible to delete, copy, or update files.

Basic Functions of a File System:

Organization of data:

* The file system organizes files and folders neatly on the disk.

* It assigns names to files and gives them a unique address.

Accessing and locating data:

* The file system ensures fast and accurate data retrieval during read and write operations.

* It keeps information (an index) about where files and folders are located.

Management of disk usage:

* It tracks empty and used space on the disk.

* It determines which area will be used when a file is added.

Security and permission management:

* Modern file systems can specify who is allowed to read, write, or delete files (for example, in NTFS).

Data protection:

* Some file systems (for example NTFS) contain a journaling system, allowing data recovery in case of disk errors.

Types of File Systems:

File systems can be of different types, each with its own advantages and limitations. For example:

* **FAT32:** Old but universally compatible; ideal for small files.

* **exFAT:** Improved version of FAT32, supports large files.

* **NTFS:** Suitable for modern Windows systems, with security and large file management.

* **ext4:** Commonly used in Linux operating systems.

* **HFS+:** File system for Apple macOS.

* **APFS:** New file system for Apple macOS and iOS.

Simple Explanation:

The file system works like a library on the disk:

In a library, every book has its own shelf, category, and registry.

The file system, on the other hand, shows where each file is located, how it is named, and who can use it on the computer.

What Is FAT32 (File Allocation Table 32-bit)?

FAT32 (File Allocation Table 32-bit) is one of the oldest and most widely used file systems. This file system, used in DOS and earlier versions of Windows, is still used today for devices that require high compatibility.

The main features of the FAT32 file system are:

* The maximum size of a single file is 4 GB, meaning one file cannot be larger than 4 GB.

* The maximum partition size is theoretically 16 TB, but in practice it is limited to 2 TB.

This limitation exists because standard formatting tools and operating

systems support only 2 TB partitions for FAT32.

One of the biggest advantages of FAT32 is that it is fully supported by all operating systems. All major operating systems such as Windows, macOS, and Linux can read and write the FAT32 file system. It also provides high compatibility between devices. Game consoles, cameras, camcorders, televisions, car multimedia systems, and USB flash drives fully support the FAT32 file system.

One of the important limitations of FAT32 is the maximum single file size of 4 GB. This means files larger than 4 GB cannot be saved on a FAT32 partition, which causes issues especially when storing large video files. Additionally, the FAT32 file system leads to more fragmentation on the disk. Fragmentation means that files are stored in parts instead of sequentially, which reduces disk performance.

The FAT32 file system does not support security features. Assigning permissions to files, managing user rights, or journaling systems such as data protection mechanisms are not available. Also, approximately 12 MB of fixed space is required for every FAT32 partition, which leads to space loss especially on low-capacity devices.

In conclusion, the FAT32 file system is mainly used in situations where compatibility is the priority. It is an ideal choice for storing files smaller than 4 GB, transferring data between different devices, and ensuring compatibility with older systems. However, for storing files larger than 4 GB, requiring security features, or effectively managing large disk capacities, FAT32 is not suitable due to its limitations. In such cases, NTFS, exFAT, or other modern file systems should be preferred.

What Is exFAT (Extended File Allocation Table)?

The exFAT file system is an improved version of the FAT32 file system. It was developed specifically to remove the 4 GB maximum

single file size limitation found in FAT32.

The main features of the exFAT file system:

* Maximum single file size: 16 exabytes (16 EB)

* Maximum partition size: 128 petabytes (128 PB)

These sizes are more than sufficient for practical use, and it is impossible to reach these limits in real-world scenarios. The exFAT file system is specifically designed for flash memory devices, USB drives, SD cards, and other external storage devices.

Advantages of the exFAT file system:

* Unlike FAT32, it does not limit a single file size to 4 GB, making it suitable for storing large files.

* Fully supported by Windows and macOS operating systems.

* Compatible with the characteristics of flash memory devices and works efficiently on them.

Limitations of the exFAT file system:

* It does not have advanced security features found in the NTFS file system.

* It does not support assigning detailed permissions to files and folders, managing user rights, granting special permissions, or audit mechanisms.

* There is no journaling system; therefore, there is no data recovery mechanism in case of disk errors or improper shutdowns.

In conclusion, the exFAT file system is used for storing large files on flash memory devices and ensuring compatibility across different platforms.

Its removal of the FAT32 file size limitation is its biggest advantage. However, due to the lack of security features, exFAT is not suitable for system drives or high-security environments.

This file system is particularly suitable for storing large media files, such as high-quality video files, on USB drives or external storage devices.

What Is NTFS (New Technology File System)?

NTFS (New Technology File System) is a modern file system developed based on Windows NT.

Its main features:

* Maximum file size is 16 exabytes (16 EB)

* Maximum partition size is 256 terabytes (256 TB)

* Supports file permissions, encryption, journaling, and other advanced features

Advantages:

* Thanks to the NTFS file security and permission system, detailed access rights can be managed for each file and folder.

* File encryption is supported, and only authorized users can access encrypted files.

* The journaling system minimizes data loss during disk errors, improper shutdowns, or system crashes, and helps with data recovery.

* It can efficiently manage large files and large-volume partitions.

Limitations:

* NTFS does not have universal compatibility like other file systems.

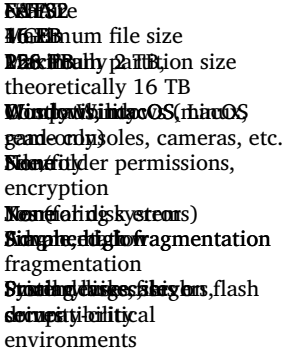
* On macOS, NTFS partitions are supported only in read mode; third-party software is required for writing.

* On Linux systems, additional software may be required for full NTFS support.

For this reason, NTFS is generally suitable for systems operating within the Windows environment.

The NTFS file system is especially ideal for computer servers, workstations, and environments that require high security. Its security features, journaling system, and ability to manage large amounts of data make this file system one of the most widely used file systems in modern computer systems.

The information provided fully and accurately explains the features of the NTFS file system. The maximum file size is specified as 16 exabytes, which does not pose any limitation for practical use. Other features — security mechanisms, journaling system, and compatibility limitations — are presented completely and correctly.



What Is Regedit?

The Registry — is the central database of the Windows operating system that stores all configuration data (program settings, hardware configuration, user parameters, system policies, etc.). Physically, it consists of several files (SYSTEM, SOFTWARE, SAM, NTUSER.DAT, etc.), but it appears as a single structure to the user.

Regedit.exe (Registry Editor) — is the official tool developed by Microsoft. With it, it is possible to view the Registry, perform searches, modify values, create/delete keys, and import/export (.reg files).

In addition to Regedit, there used to be a more powerful regedt32.exe (in older versions of Windows), but since Windows XP, regedit itself supports permissions and other functions, so regedit is mostly used today.

Extreme caution must be exercised when working with the Registry — deleting or modifying the wrong value can render the system unusable (it may fail to boot).

Besides that, Regedit is also used to bypass or circumvent official requirements of many software applications. Additionally, some users install Windows 11 by bypassing requirements such as TPM 2.0, 8th-generation or newer CPUs, and Secure Boot using Regedit during installation.

Some users have attempted to make Windows 10 Home/Pro appear as “Enterprise” or “EnterpriseS” (such as IoT Enterprise LTSC) by modifying the registry, in order to continue receiving updates after 2025.

Regedit is indeed a very powerful tool and is widely used to bypass system limitations, but Microsoft increasingly aims to block these methods.

What Is the Registry — Basic Concepts

The Registry is Windows' "settings library." It stores:

* System configurations (services, drivers, boot parameters),

* Settings of installed programs,

* User profiles and user-specific settings,

* Certain configuration parameters related to system hardware.

The Registry is made up of large blocks called **hives**. The main hives are:

* **HKEY_LOCAL_MACHINE (HKLM)** — system-level settings (for everyone),

* **HKEY_CURRENT_USER (HKCU)** — settings of the current user,

* **HKEY_CLASSES_ROOT (HKCR)** — information about file types and COM objects,

* **HKEY_USERS (HKU)** — all user profiles,

* **HKEY_CURRENT_CONFIG (HKCC)** — configuration of the current hardware.

Information in the Registry is stored as **keys** and **values**. Keys are similar to folders, and values are the individual parameters within

those folders.

Basic Components of Regedit (with GUI)

The main areas visible when Regedit is opened:

* **Left panel** — the tree structure of hives and keys (locations: HKLM, HKCU, etc.).

* **Right panel** — the values inside the selected key (name, type, value).

* **Menu and context menus** — creating new keys/values, export, import, permissions, etc.

* **Status bar / address bar** — displaying the current path.

Registry Value Types (most commonly used)

* **REG_SZ** — text string

* **REG_EXPAND_SZ** — expandable text (may contain variables)

* **REG_DWORD** — 32-bit number (commonly used for settings)

* **REG_QWORD** — 64-bit number

* **REG_MULTI_SZ** — multiple text strings (list)

* **REG_BINARY** — binary data (raw data)

Practical Use Cases of Regedit

* **Adjusting system behavior:**

Appearance and behavior of Windows components (Explorer, Taskbar, etc.)

Additional parameters regarding the operation mode of automatic services

* **Modifying program settings:**

Changing program configurations (if the program stores them in the registry)

* **Troubleshooting (fixing errors):**

Manually correcting corrupted or incorrect parameters (if the GUI does not allow it)

* **System policies and security:**

Adjusting parameters such as UAC, encryption, login restrictions, BitLocker, etc.

* **Diagnosing hardware and driver issues:**

Checking certain driver parameters (during installation or compatibility problems)

Modifying installation restrictions (e.g., incompatibility checks)

Note: This section is risky — bypassing some checks may endanger system security.

What Cannot Be Done with Regedit / Risks

* **System failing to boot:**

Deleting or modifying the wrong value or key can cause Windows to fail to start, break drivers, or corrupt programs.

* **Security risk:**

Some changes may weaken the system or leave open vulnerabilities.

* **Data loss:**

Making changes without taking a backup is risky.

Useful Technical Points (Administration and Automation)

* **.reg file format:**

Used for exporting/importing Registry changes. These files contain key and value structures as text.

* **Import/Export:**

Keys can be exported from Regedit and re-imported to another computer or restored in case of issues.

* **Permissions:**

Each key has Windows ACL (permission policy) — determines who can read, write, or delete.

* **Scripting/Automation:**

Registry operations can be automated with PowerShell or other system tools (outside the GUI, safer and reversible).

* **Audit and Event Logging:**

In enterprise environments, registry changes can be monitored and audited.

Practical Examples (Conceptual — No Action Commands)

* To modify a hidden setting of a program, the key stored by the vendor is located and its value is changed.

* To force a service to start automatically, the Run/Start parameters can be adjusted.

* To change Explorer's icon behavior, a parameter is added to the relevant key.

(*These examples are for conceptual purposes — a backup should be taken beforehand.*)

Conclusion:

Regedit is the official graphical tool for managing Windows' configuration database.

* It provides the ability to read and modify both system and program settings.

* When used correctly, it is a powerful diagnostic and repair tool; when used incorrectly, it can break the system or create security vulnerabilities.

* Backup, precaution, and attention are essential before every change.